

The
SURGICAL CLINICS
of
NORTH AMERICA

CHICAGO NUMBER

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SYMPOSIUM ON ABDOMINAL SURGERY

INTRODUCTION

SURGICAL diseases related to the intestinal tract are so numerous that in a symposium of this type we are able to include only the more important or more frequent ones. As in surgical lesions elsewhere the abnormalities encountered are of a physiologic as well as a pathologic nature. In the intestinal tract the disturbances in physiology are perhaps of more relative importance because they are so commonly of a nutritional type. The patient's inability to maintain his normal caloric intake or to assimilate the food consumed, results in inanition which has an important role in determining the type of preoperative treatment, the type of operative therapy, the amount of operating tolerated by the patient and numerous other factors which are of extreme importance in the final outcome. In addition to the actual caloric deficiency many other deficiencies including water, electrolytes, vitamins and hormones may develop; any one of these may be more important than the decreased caloric intake or assimilation of food itself.

It has been during only the past two decades that the importance of these deficiencies in the therapy and outcome of the patient's illness has been appreciated. Even now the surgeon or internist too often turns a deaf ear upon these all important factors—reflecting very unfavorably on the mortality rate and symptomatic result. Too often the surgeon devotes too much attention to operative technic alone, assuming that if the technical work has been correct and well performed the patient's recovery will be assured. All of us are fully aware of the fact that the mortality rate in many, or in fact almost all, operative

procedures has decreased sharply during the past two decades. What is not sufficiently appreciated is the fact that this improvement is due primarily to a better understanding of the physiologic and pathologic principles involved and not to an improvement in operative technic. For example, the technics of such procedures as cholecystectomy, gastroenterostomy, and gastrectomy have not been appreciably improved in the past two decades, yet the results (including mortality rate) have been sharply improved. As stated, the factor resulting in this improvement is related to a better understanding of the physiologic and pathologic principles involved and correction of as many of the abnormalities as possible in addition to performing the correct operative procedure at the correct time. The application of the correct operative procedure is particularly well exemplified in the shift toward gastric resection from gastroenterostomy and other palliative procedures previously performed for peptic ulcer.

At first thought it might appear that a detailed discussion of surgical diseases of the intestinal tract is not contributing to war surgery. True enough, the traumatic phase of war surgery is not included. I wish to emphasize, however, that the type of war surgery of which one could be proud cannot be executed unless the surgeon is constantly on the alert for numerous physiologic and pathologic disturbances which may develop following trauma. To achieve good results, such changes should not only be recognized as they develop but should actually be anticipated so that proper measures may be instituted for the prevention of their development. These changes are innumerable in type and vary tremendously in patients suffering from the same injury or disease. It is this extreme variability or inconsistency which makes it necessary for the surgeon to be well informed from the standpoint of physiology and pathology regardless of the type of work performed by him. Good results cannot be achieved at least in the major injuries by looking upon the injury purely from the mechanical or physical standpoint.

GALLBLADDER DISEASE*

RALPH BOERNE BETTMAN M D F A C S † and WILLIAM J TANNENBAUM M D ‡

WE HAVE chosen two cases to present to you this afternoon, each of which represents a different form of gallbladder disease and from each of which we may be able to draw some conclusions. The data on these cases incidentally have all been gathered by our Gallbladder Group and a word or two concerning the functioning of the group may not be amiss.

METHOD OF STUDY

When a patient first enters the hospital and that patient has in his history symptoms which suggest gallbladder disease, he is immediately transferred to the Gallbladder Group and seen by one of the medical men and one of the surgeons of the group. If there is no emergency, it becomes the duty of the medical man to work him up. The medical man is aided by our laboratory technician, the x-ray specialists and any other consultants he may wish to call in. After the case has been carefully prepared the group as a whole, which includes not only the men mentioned but also a physiologist and usually one or two research residents, meet and discuss the case, accept or disapprove the version of the medical man and then decide as to the course of treatment. If surgical, the surgical team with its residents and interns takes over and carries out the rest of the treatment, with the medical man this time acting as consultant. When the patient is about ready to leave the hospital, our statistician and the research worker see the patient and arrange for the postoperative 'follow up'. The group as a whole has been so delighted with this cooperative study of the patient that we have chosen to treat both our private and ward patients in this manner.

The conclusions which will be expressed in my clinic this afternoon are those which we have reached through this group study.

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CASE I CHOLELITHIASIS

History

The first case is the usual garden variety of cholelithiasis. This patient, a thirty five year old black haired black eyed Italian woman who as you can see is rather emaciated, came into the clinic with a history of typical gallbladder colic. We purposely chose this woman of thirty five years of age with black hair and loss of weight to emphasize the fact that the well known line about "fair fat and forty" should not mislead us. Most of our gallbladder cases probably developed long before the patients were forty and now with our improvement in diagnosis we can establish the fact that they have gallbladder disease earlier than was formerly believed customary. The color of the hair as far as we have observed in our clinic seems to play no role whatever. Not long ago a surgeon from one of the Indian reservations out west visited our clinic and told us that in the Indian tribe over which he has medical jurisdiction the incidence of cholelithiasis is particularly high. Whether or not there is any true relationship between obesity and gallbladder disease we cannot say. We will admit however that most of our gallbladder patients seem fairly well nourished. Before drawing any conclusions from such a fact however we are in need of more specific data on this subject. It is true of course that a fatty diet stimulates gallbladder activity but whether the increase of gallbladder symptoms is due to the fact that obese persons are inclined to eat fatty meals or to the fact that because of their obesity the gallbladder is more apt to be affected we do not know.

This patient's symptoms of gallbladder colic started a few months after the birth of her second child. Here again we are unable to correlate the cholelithiasis with the pregnancy and in fact our second and third cases today are both men. We will not go into detail concerning the attacks of gallbladder colic in the present patient because the symptomatology of gallbladder colic is well known to all of you. Suffice it to say that these attacks have been increasing in frequency and severity and they have been associated with nausea and vomiting but no fever. Although the patient thinks she looks yellowish the icterus index taken during a previous attack was normal.

The patient has had symptoms suggestive of cardiac disease and the electrocardiographic tracings show signs which might accompany a coronary sclerosis. The association of cardiac dis-

case with gallbladder disease is not infrequent. In some way the presence of gallstones seems to aggravate the cardiac condition. We have had many instances especially in elderly men in which the two conditions have been associated and in which the removal of the stone filled gallbladder seemed to have a very definite beneficial effect upon the heart condition—beneficial to the extent that the frequency of the heart attacks was very appreciably decreased. So strongly do we believe in this correlation that the presence of the cardiac complication is an indication rather than a contraindication for operation.

Diagnosis

We will not go into the details of the laboratory diagnosis for the simple reason that in our opinion a clinical evaluation of the patient is of more value in establishing the diagnosis and in estimating the patient's ability to withstand operation than the results of the laboratory examination. There is one important exception to this statement. We feel that the *x ray* is of immeasurable value in the diagnosis. Recently we surveyed a series of 250 consecutive patients who had been operated upon for cholecystectomy and in whom gallstones had been found at operation. In 244 of these the *x ray* diagnosis had been positive for gallstones in three doubtful and in only three that is just a little over 1 per cent had the *x ray* report come back a normal functioning gallbladder with no stones seen. In each of these three cases one small stone was found at operation in what appeared to be an otherwise normal gallbladder. Few clinicians will boast of a 98.5 per cent accuracy in diagnosis as was possible with the *x ray*.

By positive *x ray* findings we do not mean that the 244 cases actually showed stones. We do mean though that in those 244 cases one of two conditions was found either the stones were actually demonstrated by means of the Graham Cole test or the gallbladder showed no dye concentration whatever in spite of a repeat film with the dye being given at two different times before the *x ray* study was begun. We warn you not to be satisfied with a single negative dye test film because very frequently the patient may forget to tell you that she vomited up all the dye shortly after taking it and occasionally the rate of absorption and excretion of the dye has been so abnormally fast that twelve hours after the dye was ingested none was left in the gallbladder.

Preoperative Care

The preoperative treatment in this case was practically the same as that for any laparotomy. We still advise the patient to take a high protein, high carbohydrate diet before operation. Spinal anesthesia is being used. We like spinal anesthesia because of the ease with which the operation can be conducted under it. If for any reason spinal anesthesia is contraindicated or if our patient prefers being put to sleep, we have no hesitancy in using cyclopropane.

Operation

The line of *incision* is transverse and extends from the edge of the costal margin just slightly across the midline, a few centimeters above the level of the umbilicus (Fig. 1 A). This patient, in spite of her slight build, has a rather flaring costal arch, and in this type of patient a transverse incision is ideal. The incision splits the external oblique muscle and the internal oblique and transversalis muscles in the direction of their fibers. It cuts horizontally across the fascia of the rectus muscle. The rectus muscle is cut transversely to its fibers. This at first would appear to be mutilating and we have often been asked, does not the rectus muscle retract within its sheath when so cut? As a matter of fact, no such thing occurs. Throughout the operation the cut fibers of the rectus muscle do not retract, and when the rectus fascia is repaired the rectus muscle is approximated and heals with a barely perceptible scar. We had the opportunity recently to examine at autopsy two patients who had been operated upon with a transverse incision five and eight years previously and found the results as related.

The posterior fascia of the rectus muscle and the peritoneum are opened transversely, which is in the direction of the fibers of the posterior sheath of the rectus. This can be easily demonstrated at operation by stretching the wound after the peritoneum has been entered through a short transverse incision. The splitting will be transversely. In closing such a wound it will be an agreeable surprise to those who are not familiar with the transverse incision to note that the closing sutures do not tear out.

After the abdominal cavity is opened we always conduct a careful *intraperitoneal exploration*. We start at the right upper quadrant of the abdomen, proceeding laterally downward to the pelvis, into the pelvis itself, over to the left side, following

upwards along the course of the descending colon, and then after the left upper quadrant has been reached sweep across the abdomen back to the gallbladder region. We have found that unless we employ a systematic routine such as we have described we are apt to overlook some part of the peritoneal space

INCISIONS

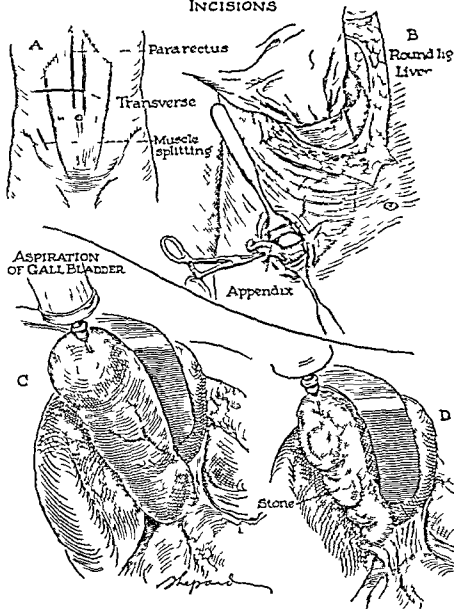


Fig 1—Technic of cholecystectomy

The gallbladder is usually found distended owing to the fact that the patient has been in a fasting state for from eight to twelve hours before coming to the operating room. This distention interferes markedly with the visualization of the cystic and common ducts. *Aspiration of the gallbladder* (Fig 1 C)

will facilitate the inspection of this important region of the operative field. We aspirate the gallbladder with a fairly large needle attached to a 50 or 100 cc syringe. The puncture wound is easily closed with a curved snap. There should be no soiling at all from such an aspiration. If a drop or two of bile should escape we are not worried because there will be no reaction.

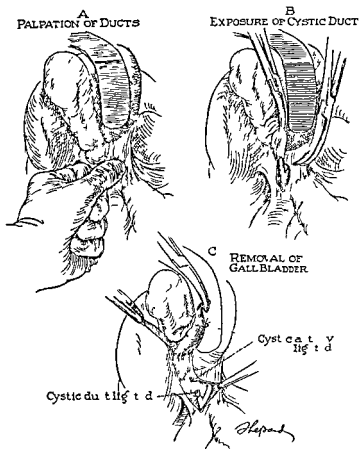


Fig 2—Technic of cholecystectomy (Continued)

The first step of the operation consists in dissecting the hepatoduodenal ligament and thus exposing the cystic duct (Fig 2 B) the common duct and in most instances the cystic artery. The common duct is always inspected to make certain that it is not dilated. If it were markedly dilated it would be opened irrespective of whether there was or was not a history of jaundice or whether stones could be palpated within the duct. On the other hand we do not open the common duct simply because

the gallbladder contains small stones or gravel. If the patient has not been jaundiced, if the common duct is not enlarged, and if we do not actually palpate stones in the common duct (Fig. 2 A) we feel that it is much wiser not to open the common duct.

As soon as it is isolated the cystic duct is ligated with a single ligature and cut between the ligature and a clamp placed upon it below the gallbladder. Usually the cystic artery is easily identified and ligated. Only rarely is the cystic artery ligated with the cystic duct. Although many articles have been written on the subject of anomalous positions of the cystic artery, we find that on the whole it is a very dependable structure and is usually in the position where most textbooks say it should be. Even in those instances in which it extends to the right of the cystic duct or over it, it is easily identified if a little care is taken.

The gallbladder is removed from the bottom upwards (Fig. 2 C), an effort of course being made not to injure the liver. Unless the gallbladder bed is oozing we make no attempt to close it.

The abdominal wall is closed in layers *without drainage*. We began to omit drainage in simple cholecystectomies such as this about ten years ago and have never regretted this omission. On the contrary, our patients seem to have been infinitely better off without drainage. We recently reviewed about 500 cases of simple cholecystectomy in which there had been no drainage and found that in this group we had six cases that required reoperation within ten days of cholecystectomy (two for acute appendicitis, two for twisted ovarian cyst, and two for evisceration). One of the eviscerations was secondary to pneumonia and the other resulted when a psychotic patient jumped out of bed immediately after operation and had to be forcibly subdued. In none of these cases was any bile found in the intraperitoneal fluid.

Postoperative Treatment

The postoperative treatment is similar to that following any laparotomy. Those patients who have had a transverse incision as in the present instance are permitted out of bed as soon as they desire, some as early as the third postoperative day. In our opinion there is less chance of a wound disruption following the use of a transverse incision, and we are definitely convinced that the sooner the patient is up and out of bed the easier will be the convalescence.

In patients who have a narrow costal angle a transverse incision does not give us adequate exposure and in them we use the typical right paramedian incision. We keep these patients in bed for at least a week. Whether or not this is necessary we cannot say. It may be entirely due to prejudice and it may be that the paramedian incision is just as strong and that patients on which it is employed could just as well get out of bed early as those with a transverse incision. It is true, however, that we have seen but one case of disruption following the transverse incision as compared to several following the paramedian. It is also true that the stitches which are used to close the paramedian incision have a tendency to tear out under certain conditions as when the patient is not well anesthetized while this is not the case with a transverse incision.

The patient now being demonstrated is ready to go home on her twelfth postoperative day. Symptoms referable to her gall bladder condition will stop and we hope the symptoms referable to her cardiac condition will be much less frequent.

CASE II ACUTE CHOLECYSTITIS

History

The next patient is a man in his sixties who was sent to the hospital two days ago complaining of severe pain in the upper abdomen radiating to the back which had been present for thirty six hours before admission. He said that he had a high fever at home and on admission to the hospital he was found to have a temperature of 102.6 F. He was nauseated and vomited shortly after the attack started and the nausea and vomiting have persisted. He can remember no previous attacks such as this and in fact boasts that he has always been in perfect health, has never had to consult a doctor and that he did not know before this attack that there was such a thing as abdominal discomfort or pain in spite of the fact that he has not refrained from *injurious eating and drinking*.

Diagnosis

The diagnosis of an acute gallbladder condition as the probable cause of his suffering was made from the facts that the location of the pain was over the gallbladder region and radiated to the right scapular region and there was definite muscle rigidity throughout the right hypochondrium with practically no rigidity on the left side or in the lower abdomen.

Upon admission to the hospital the patient was immediately given a hypodermic to relieve his pain and glucose intravenously was started. Within a few hours he seemed to improve so materially that we have decided to await the possible abatement of the acute attack and then to perform a cholecystectomy if our further examinations confirm our original diagnosis.

Preoperative Care [When Operation Is Indicated]

If we had planned to operate at this particular time our preoperative treatment would have been as follows. If the patient had been severely dehydrated before coming to the hospital he would have received at least 1000 cc. of 5 per cent glucose in normal saline followed by another 1000 cc., or more if necessary of 10 per cent glucose in normal water. These two solutions are readily available in almost any clinic and clinically at least seem to give as satisfactory results as the more chemically complicated ones. We like to add the normal saline in those cases in which there has been a good deal of vomiting and therefore a loss of hydrochloric acid. We feel of course that the glucose helps as a source of energy and as an aid to overcoming the depletion in the liver (if such occurs in an acute gallbladder). Inasmuch as the patient was not jaundiced there probably would be no indication for vitamin K although we probably would have tested for vitamin K if we should have had plenty of time. Inasmuch as recent studies have definitely shown that along with loss of other substances loss of protein matter is extremely important we probably would have given this man either a blood transfusion or some blood serum or plasma especially had he been in shock. All this could have been done within a comparatively short time and would not have delayed his operation. However as we said this patient improved immediately after receiving his hypodermic and the first intravenous glucose solution and therefore we have postponed operation.

Sex Incidence

This patient brings up several interesting points for discussion. It is interesting to note that whereas the incidence of gall bladder disease in men as compared to women is about 1.8 the incidence of acute cholecystitis has been about 2.5 in our series. Just why gallstones should be more apt to show acute manifestations in men than in women we do not know. It is also interesting to note that this attack of gallbladder disease is apparently

the first that this man has experienced. As he has not yet been operated on we cannot tell how long or how chronic his disease has been but very frequently in a case of this nature we find a gallbladder wall which has been chronically thickened and stones the size of large marbles which obviously have taken a long time to develop. Yet as we said before the first appearance of gallbladder symptoms has been this acute attack. Whether or not gallstones are less apt to cause symptoms in men than in women we are not ready to say however it is an interesting field for speculation. Although we have seen acute gallbladder disease in men of all ages it is usually found in the elderly.

Treatment

The treatment of an acute gallbladder attack such as this requires great individualization and cannot be categorically set forth. For instance if the attack from which this man was suffering when he was admitted had continued in the same virulent degree we would certainly have advised immediate operation. Inasmuch as it was ameliorated almost immediately it seems to us obvious that the safest procedure is to wait for its subsidence. Had we operated upon the patient immediately we would have had to make a choice between *drainage of the gallbladder* and *cholecystectomy*. We cannot state definitely which of these two procedures we would have adopted. It is interesting that in the last thirty cases of acute cholecystitis seen at the hospital with a temperature of 102 F. or over and in which operation was performed within the first twenty-four hours of the patient's hospital stay drainage was carried out in twenty-four and cholecystectomy in only six.*

Thus clinically at least we seem to favor drainage of the gallbladder. We think the explanation for this is rather apparent. We perform drainage of the gallbladder either under local anesthesia or short intravenous anesthesia. The incision is small and directly over either the palpable mass or the site of greatest rigidity and tenderness. Almost invariably as soon as the peritoneal cavity is entered the gallbladder comes into view. Occasionally it is true that the gallbladder may be covered with adherent omentum but this is not usually the case. Usually the red, edematous, markedly distended gallbladder lies directly in the incision and

Incidentally it may be of interest to note that during the time required to amass these thirty cases of acute cholecystitis over 500 cholecystectomies for cholelithiasis were performed—ratio of one case of acute cholecystitis to every six cases of cholelithiasis.

it is possible to expose it without disturbing any of the surrounding tissue at all. As soon as the gallbladder is exposed we insert a very large bore needle (the size of a small trocar) attached to a siphon. As soon as the liquid contents of the gallbladder are removed it becomes easy to grasp the gallbladder with an Allis forceps and bring it up into or frequently even out of the wound. A catheter is then placed into the opening which was made by the trocar and immediately attached to a suction apparatus.

Of late we have at this point been dusting sulfanilamide or sulfathiazole powder in the wound around the gallbladder. It is rather difficult to ascertain how much benefit has accrued from this additional procedure because even before the advent of the sulfonamide drugs our results from this type of drainage operation were highly satisfactory.

The gallbladder is attached to the abdominal wound with one or two silk sutures and the operation is completed. The entire procedure has required less time than it has taken me to describe it. The operative shock is nil. The relief from such a procedure is immediate and usually great. The convalescence is usually rapid and uneventful.

This simple drainage of the gallbladder is attended by such good results that we are now rapidly increasing our indications for it. It is our belief that the danger of rupture of the gallbladder is eliminated the moment the gallbladder is drained, that is the moment the intracystic pressure has been relieved. In our experience the danger of complications such as localized abscess and cholangitis is lessened by the drainage. Again in doubtful cases presenting some danger in delay we feel that it is safer to await the subsidence of the acute attack with a drainage tube in the gallbladder than without one.

Drainage of the gallbladder does not materially increase the difficulty of subsequent cholecystectomy. In fact we are not at all sure that it does not simplify it. We have no way at all of determining whether the adhesions around the gallbladder, which are one of the chief obstacles in the performance of cholecystectomy after an acute cholecystitis are more or are less dense when the gallbladder attack subsides slowly in the natural way or when it subsides quickly following drainage. Theoretically at least drainage of the gallbladder as we perform it with no foreign body whatever in the peritoneal cavity should not complicate the following operation. A secondary operation was

performed within a week to several months after drainage in twenty of the twenty four cases under discussion and the secondary operation was not difficult. The other four cases were in aged persons in whom we felt that it was better to leave a draining biliary sinus than to subject them to further risk. Incidentally most patients are apparently perfectly normal and symptom free following drainage and often it is rather difficult to induce them to have the stone filled gallbladders removed.

As mentioned *cholecystectomy* for acute *cholecystitis* complicated by a temperature of 102 F or over has been performed six times in our recent series of thirty cases. All six patients recovered nicely. In none of the cases did we have more than a moderate amount of postoperative morbidity and of course none of these six patients required re operation. It would seem therefore that *cholecystectomy* has certain advantages over primary *cholecystostomy* and secondary *cholecystectomy*. Our series of six cases is altogether too small however to be completely convincing.

Technically the removal of an acutely inflamed gallbladder is much more difficult than that of a chronically inflamed one. The gallbladder wall itself is very edematous usually extremely friable. The hepaticoduodenal ligament which must be explored of course in order to isolate the cystic duct is edematous thick and contains as a rule veins which are more engorged and seem to bleed more easily than those we encounter in the usual gallbladder operation. What seems to complicate the procedure probably more than anything else is the enlargement of the glands situated in the hepaticoduodenal ligament. These glands are large interfere with visualization of the ducts bleed easily. Finally theoretically at least one might expect a greater bacterial accumulation in the adjacent structures in the acute case than in the chronic cases.

With the foregoing facts in mind we have concluded that the benefits which accrue from the resection of a really acute gall bladder as compared to the possible dangers are not sufficient to justify it. One word of explanation is perhaps necessary. It will frequently happen when the surgeon is performing an elective operation for what he thinks is a chronic *cholecystitis* due to *cholelithiasis* that he will encounter a reddened slightly edematous gallbladder obviously acutely inflamed. In such a case we think it would be folly to perform any other procedure than the *cholecystectomy* that was begun. We are not referring to this

type of acute gallbladder which can be treated in the same manner as any chronically inflamed gallbladder. We are referring to the type of acute inflammation that we would have found upon immediate operation in this gentleman whom we are now demonstrating or in any other patient who is admitted with the signs and symptoms of an acute virulent infection, a temperature of 102° F and over and usually a leukocyte count between 20 000 and 30 000. A failure to distinguish between these types is the cause of much confusion in the treatment of acute cholecystitis. An acute clinical cholecystitis is a definite entity which can be easily recognized before operation. An acute cholecystitis from the point of view of the pathologist is not infrequently found in patients who clinically are not suffering from a virulent acute attack.

What we shall do with this patient. The acute attack has abated. Careful physical examination has revealed that in spite of the man's age he is in excellent physical condition except for his nonfilling gallbladder. He undoubtedly has gallstones. He is however a very active gentleman who still absents himself from the city frequently on long business trips. His chief pleasure in life is his summer's retirement to a cottage up in the north Wisconsin woods where as he says he goes native. Inasmuch as another attack is imminent and might very well occur in a situation where hospital facilities would be meager or entirely absent we are going to advise him to have his gallbladder removed.

SURGERY OF THE PANCREAS

WARREN H. COLE, M.D., F.A.C.S.†

THE pancreas like a few other organs of the body is an organ of internal and external secretion. Derangement or disease may affect either of these two systems. As with other tissues the pancreas may be the seat of various disease processes such as inflammation, cysts and tumors.

HYPOGLYCEMIA

The condition known as hypoglycemia (decreased blood sugar level) is of course the opposite of diabetes which is primarily a medical disease and will not be discussed here. Although the first concrete description of hypoglycemia with a pathologic explanation (Wilder and associates¹) was based on the presence of carcinoma of the islands of Langerhans, this etiologic factor is extremely uncommon. Hypoglycemia is more commonly produced by benign adenomas of the islets or by endocrine disturbances as yet poorly understood.

Hypoglycemia Due to Tumors of the Islets

Hypoglycemia from this cause is relatively uncommon but it is so easily confused with other diseases of a neuropsychiatric character that everyone must be familiar with it. The tumors producing the condition are usually single but may be multiple. They are most often found in the body of the pancreas although they occasionally occur in the head. They rarely attain a size greater than 2 cm. in diameter. They are identified by a bluish pink color and are partially circumscribed.

The *clinical manifestations* of hypoglycemia due to islet cell tumors are extremely dramatic. Perhaps the earliest symptom is an attack of weakness and mental confusion occurring several hours after a meal. With this attack of weakness there may be a coarse tremor and a cold sweat. As the disease progresses these attacks become more severe. The irrationality shades over to stupor during which time consciousness is completely lost.

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although the patient may obey simple commands. Even during mild attacks the patient usually is unaware of what he is doing and has no memory of incidents occurring during the attacks. In the later stages convulsions may occur which resemble those occurring in epilepsy or brain tumor. However such attacks rarely are accompanied by aura. With few exceptions the attacks occur only after a period of several hours has elapsed since eating. They are thus commonly observed early in the morning as

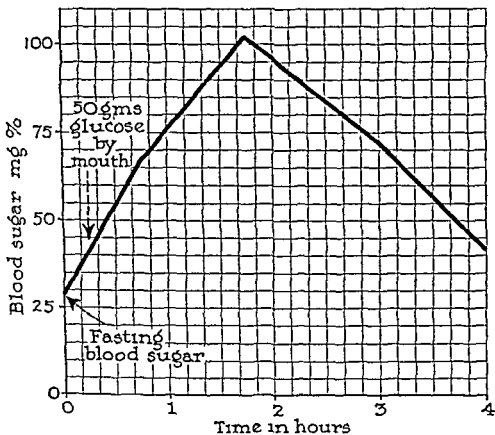


Fig 3—Glucose tolerance test in patient with hypoglycemia due to adenoma of the pancreas (Case I). The rise in the blood sugar level following oral glucose was much less than normal.

the patient arises from his sleep. If the patient is undergoing considerable exercise the interval since eating may be greatly shortened since metabolic demands will accentuate development of the hypoglycemia. There are few neurological signs demonstrable even during attacks.

The diagnosis is confirmed by *laboratory data* (Fig 3). During an attack the blood sugar will be markedly decreased being as low as 20 mg per 100 cc. The carbohydrate tolerance is increased so that the peak level following a tolerance test may

be no higher than 100 to 105 mg per 100 cc in contrast to a normal reaction of about 200 mg. The patient is unusually sensitive to insulin.

The *treatment* of adenoma of the pancreas is surgical excision of the tumor. With practically no exceptions excision of the tumor results in a complete cure of the condition except that part of the mental deterioration resulting from prolonged hypoglycemia may be permanent. If the attacks are not relieved by excision of the tumor it is usually safe to assume that a second tumor exists and must also be removed. The tumors are usually readily palpable although sometimes not very visible when buried in the body of the pancreas. Occasionally the surgeon will decide upon subtotal pancreatectomy assuming that a tumor perhaps exists but is buried so deeply and is so small that it can not be palpated. Such a procedure is quite justifiable since most of the tumors are present in the body and tail of the pancreas and since subtotal pancreatectomy is associated with a low mortality rate.

If the dissection required for removal of the tumor is extensive there may be drainage of pancreatic fluid for several weeks following operation. For that reason a drain must always be left in place when the pancreas has been excised. The drainage of the pancreatic fluid does not result in significant skin irritation since the trypsinogen is not yet activated.

CASE I—S. F. The patient is a woman aged fifty-two years entering with the complaint of attacks of mental confusion, pallor, sweating and irrationality of nine months duration. The first attack followed news that her son probably had embarked for military service overseas. Attacks were mild at first. They consisted of speechlessness, failure to respond to questions and inability to pay attention to conversation. These usually occurred in the morning before breakfast. About three months after onset they became more severe and were epileptiform in character. There was considerable twitching of the muscles of the extremities and salivation. Her personality changed somewhat, being more congenial but somewhat childlike. Recently she has been very stuporous and in fact totally unconscious during her attacks. The blood sugar determination performed on the blood drawn during an attack revealed a level of 21 mg per 100 cc. Administration of 100 cc of 20 per cent glucose restored the patient to complete consciousness. Frequent feedings including ones during the night would prevent the attacks. A glucose tolerance test revealed a remarkable tolerance to glucose, the level rising to only 102 after the feeding (see Fig. 3).

At operation performed through a transverse upper abdominal incision a nodule about 1.5 cm in diameter was found buried deeply in the body of the pancreas. It did not have the typical bluish pink color but as a matter of fact had the color of normal pancreas. However it was palpated as such a definite tumor nodule that a diagnosis of adenoma seemed certain. Dissection of the nodule from the body of the pancreas broke into a large branch of the splenic vein posteriorly resulting in considerable hemorrhage. It was necessary to transect the pancreas which was already more than halfway transected to control the hemorrhage. After approximating the cut edges of the pancreas the wound was closed around a drain leading down to the pancreas.

The hypoglycemia was relieved immediately, the blood sugar being 176 mg per 100 cc two hours after operation, however some glucose had been given in the meantime. Two days after operation her blood sugar was 153 mg early in the morning after five hours fasting. After ten hours fasting it was 128 mg. This in reality is a mild diabetic response and is in sharp contrast to a blood sugar level of 39 mg after five hours fasting before operation. She had no attacks following operation indicating that the adenoma was the sole explanation of the hypoglycemia. A small quantity of pancreatic juice drained from the wound for five or six weeks before the wound closed. This drainage was not irritating to the skin.

Hypoglycemia Not Due to Tumors of the Islets

This type of hypoglycemia is much more common than that due to adenomas. The mechanism of the production of this type of hypoglycemia is not clearly understood. At times it definitely appears to be due to disturbances of the pituitary. On many occasions it appears definite that the individual is unusually sensitive to insulin and its effects. The insulin test will give valuable information in this regard.

The *clinical manifestations* are very similar to those noted in hypoglycemia due to adenoma. However, in the so called idiopathic type the symptoms are milder and rarely are convulsions and total loss of consciousness encountered. The most common symptoms are weakness, early fatigue, malaise and headache. Undue hunger, particularly for sweet foods, is commonly noted.

The *treatment* of this type of hypoglycemia is chiefly medical although subtotal pancreatectomy has been performed on numerous occasions. However this operation is successful in the relief of symptoms in less than half the cases. Medical treatment consists of frequent feedings. Small quantities of insulin have been recommended (John). A diet high in protein (Conn³) should

be tried since the conversion of protein to carbohydrate is so slow that the stimulus for insulin formation is minimal

ACUTE PANCREATITIS

Acute pancreatitis occurs with varying degrees of intensity but in general cases may be classified as acute hemorrhagic or acute edematous. The former is much more severe than the latter though much less common. Gallbladder disease is unquestionably an important factor in etiology. Proof of this relationship is offered by the fact that over three fourths of the patients with acute pancreatitis have gallbladder disease and rarely do attacks of acute pancreatitis persist after cholecystectomy.

Acute Hemorrhagic Pancreatitis

Although acute hemorrhagic pancreatitis is less common than the other types it is much more serious inasmuch as fatalities frequently occur regardless of the type of treatment instituted.

The *clinical manifestations* are dramatic. Pain develops suddenly and with great intensity being located in the epigastrium frequently radiating posteriorly and to the left. Commonly the disease develops after a full meal. Shortly after onset pain, nausea and vomiting are apt to develop. The patient rapidly becomes prostrated and is confined to bed. Examination reveals marked tenderness in the upper abdomen with muscle spasm over the entire area. Mild jaundice is occasionally observed. The skin is cold and covered with cold sweat. The pulse is rapid and soft. The patient appears to be in a mild state of shock although rarely does the pressure drop sufficiently to be unobtainable. Glycosuria is not uncommon. Blood amylase determinations in the early days of the disease reveal an elevation. The level returns to normal within two or three days however regardless of the progress of the disease. The white cell count is elevated. The temperature is variable frequently being subnormal.

Treatment may be difficult to decide upon particularly since there will be difficulty in eliminating perforation of a peptic ulcer or some allied condition demanding operation. It is true that the degree of prostration frequently may be sufficient to eliminate perforation of a peptic ulcer. If the perforation of a peptic ulcer cannot be eliminated as a possibility laparotomy will be necessary. In the presence of acute hemorrhagic pancreatitis the pancreas will be found to be enlarged, edematous and of a hemorrhagic color. Numerous areas of fat necrosis will

be found in the peritoneal surfaces and omentum. A drain is placed down to the necrotic pancreas but the pancreas itself cannot be drained since it consists of lobules supported by fibrous tissue. Cholecystostomy with removal of stones may be indicated. In other words decompression of the biliary tract and drainage of the pancreas are indicated if operation is performed. If the diagnosis can be made with certainty however, it appears that operation is not indicated although there is a difference of opinion on this point.

Supportive treatment is of course very important in view of the prostration, falling blood pressure and increasing pulse rate. Transfusions and intravenous glucose are indicated. Morphine is necessary for pain. Absolute rest with freedom from mental worry is of course essential.

The patient with acute hemorrhagic pancreatitis must be observed carefully postoperatively particularly since there is a strong tendency toward the development of abscesses about the necrotic pancreas. If the patient has been operated upon the drain should be left in for several days hoping to drain any abscesses which might develop. If emergency operation has not been performed the abscess will manifest itself as an indurated area in the epigastrium with an increase in the amount of fever, tachycardia and similar manifestations.

Acute Interstitial (Edematous) Pancreatitis

Acute interstitial pancreatitis is much more common than hemorrhagic pancreatitis and is associated with a relatively low mortality rate.

Clinical manifestations of the disease are similar to those described under hemorrhagic pancreatitis but are much milder. The pain may be aggravating and severe and muscle spasm pronounced but prostration does not occur. The temperature is variable being elevated on some occasions and normal on others. The pulse rate shows only slight elevation. Nausea is common but vomiting is unusual. Acute symptoms are inclined to subside spontaneously within two or three days, as does also muscle spasm but tenderness usually remains for several days. As in hemorrhagic pancreatitis blood amylase is elevated for forty-eight to seventy-two hours after the onset of the attack (Fig. 4) but recedes to subnormal after that time (Elman⁴). The white cell count is elevated.

The treatment of acute interstitial pancreatitis is related to the

biliary tract After the acute symptoms have subsided cholecystograms should be obtained If cholecystography reveals a pathologic gallbladder cholecystectomy is indicated since gall bladder disease is presumably the major etiologic factor in the majority of cases Since there is a great tendency for attacks of acute edematous pancreatitis to recur it is usually advisable to take care of the biliary tract disease as soon as the edematous

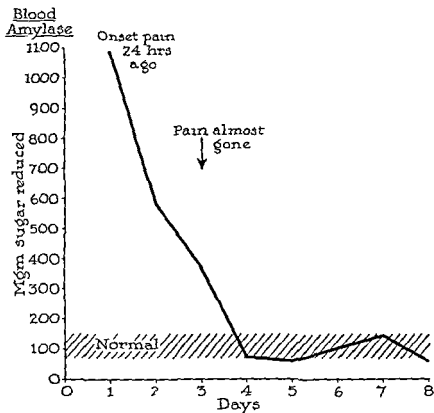


Fig 4—Blood amylase readings in a case of acute edematous pancreatitis (Case II) As is usually the case the level returned to normal in about forty eight hours.

pancreatitis has subsided because a delay allowing numerous attacks of pancreatitis might result in serious damage to the pancreas

CASE II—E H The patient is a forty four year old Negress who came in with a history of onset of pain in the epigastrium twenty four hours previously radiating to the right side and somewhat posteriorly to the back The pain at times radiated up into each shoulder

der chiefly to the right. The attack came on suddenly an hour after a heavy lunch. Vomiting occurred several times shortly after the onset of pain. Since then she had complained of painful eructations. She had three previous attacks within the last several months but they were milder in character.

Examination revealed diffuse tenderness over the entire epigastrium. The blood amylase was 1085 (normal 70 to 150) and gradually came down to normal in three days as illustrated in Figure 4. The temperature was normal on admission but by the next day a slight fever with the temperature ranging between 100° and 101° F developed and persisted for about five days. Tenderness remained for several days and had not completely disappeared until about two weeks following onset. Cholecystograms were obtained and revealed a slight decrease in concentration with a deformity suggesting pericholecystitis.

The presence of a gallbladder capable of concentration complicated the therapy in this case since the examination revealed evidence of only mild disturbance in gallbladder function. After observing the patient for a few weeks however it was finally decided that in view of the deformity of the gallbladder suggesting cholecystitis she should have a laparotomy with the idea of performing a cholecystectomy if disease was found.

At operation two months after the acute attack the gallbladder was found to have a wall of normal thickness but there was a tumor nodule about 1 cm in diameter on the margin adjacent to the liver. The pancreas was still indurated and a few areas of fat necrosis remained. The persistence of fat necrosis and an indurated pancreas was not unexpected since on numerous occasions we have observed such residual evidence of acute pancreatitis for several weeks following cessation of symptoms. Except for the presence of the tumor we might have concluded that our decision was erroneous and closed the abdomen without performing the cholecystectomy. However in view of the tumor nodule and the known relationship of gallbladder disease to pancreatitis we decided to remove the gallbladder which was accordingly done by Dr Slaughter.

Insufficient time has elapsed since recovery of the patient to determine whether or not cholecystectomy will put an end to the attacks of acute pancreatitis. It is my prediction however that in spite of the fact that the gallbladder was not seriously diseased she will have no further attacks of pancreatitis. Microscopical examination of the tumor nodule revealed it to be necrotic material (not resembling fat necrosis) which may have been the residue of a local infection.

CARCINOMA OF THE PANCREAS

Most of the malignant tumors of the pancreas are adenocarcinomas occurring most commonly in the head. They are fairly malignant and on many occasions metastasize rapidly. For some strange reason they are much more common in men than in women.

Clinical Manifestations—The clinical manifestations develop insidiously and consist initially of weakness and anorexia. Weight loss develops early and jaundice with acholic stools likewise appears reasonably early if the tumor is located in the head of the pancreas. Ordinarily carcinoma of the pancreas is supposed to be a painless disease. However this is not true since at least 25 to 30 per cent of the cases are accompanied by epigastric pain of significant intensity. Differentiation from stone in the common duct by consideration of the amount of pain may be quite difficult particularly since the pain associated with stone in the common duct becomes insignificant a day or two after onset of the attack. If the tumor is located in the body or tail of the pancreas pain appears to be even more prominent than when the tumor is located in the head. This pain commonly radiated posteriorly and to the left.

Diagnosis—Examination may not be very helpful in establishing diagnosis except that the jaundice (if present) is indicative of common duct obstruction. Occasionally a distended gall bladder can be palpated. This exemplifies the importance of Courvoisier's law which is extremely helpful in establishing the diagnosis particularly on the operating table. If the obstruction of the common duct is due to a carcinoma of the pancreas the gallbladder is usually thin walled and distended whereas it will be shrunken and fibrotic in case obstruction is caused by a stone.

Differentiation from stone in the common duct and intrahepatic jaundice (e.g. acute catarrhal icterus) becomes important. Acute catarrhal icterus is relatively painless and has an insidious onset similar to carcinoma of the pancreas. However most patients afflicted with this disease are young adults. Although the stools may be acholic at the onset of the disease normal color usually appears after the first several days. This is in sharp contrast to the situation in carcinoma of the pancreas since the stools gradually become acholic and remain so permanently after blockage has become complete. When the obstruction is produced by a stone in the common duct the color of the stools may alternate because of the intermittent character

of the obstruction Liver function tests may be quite helpful in establishing a diagnosis insofar as they are apt to be positive in acute catarrhal icterus and in obstruction by stone, whereas they will be negative at least in the early stages, of obstruction in carcinoma of the pancreas

Treatment—The treatment of carcinoma of the pancreas is surgical but unfortunately, total excision of the tumor is rarely possible because it is so often inoperable when the patient is seen. If the tumor is early, located in the head and no metastases are present resection of the head of the pancreas should be performed. The success of this operative procedure is made possible by the work of Whipple and associates⁵ who recommend a cholecysto enterostomy at the first stage and at the second stage removal of the head of the pancreas and duodenum reestablishing intestinal continuity by a gastro enterostomy. One stage operations are performed and may be preferable if the patient is a fairly good operative risk. Details of the various types of operations may be found in the splendid monograph by Brunschwig.⁶ If the tumor is inoperable anastomosis between the gallbladder and stomach or duodenum will be advisable. This operation is ordinarily performed results ultimately in an ascending cholangitis but the patient is usually near death from metastases by the time this occurs.

These patients need expert preoperative and postoperative care consisting of intravenous glucose transfusions administration of various vitamins particularly K and efforts to improve nutrition. If resection is contemplated several donors must be available.

CYSTS OF THE PANCREAS

Cysts of the pancreas may be of several types including cystadenoma retention cysts and pseudocysts but the latter are of primary importance since they are by far more frequent than the others. The pseudocyst does not have a true epithelial lining. The capsule in reality is made up of connective tissue. The pseudocyst results usually from trauma to the organ or is a sequel to acute pancreatitis. The fluid contained in the cyst is usually straw colored but may be sanguineous because of slight hemorrhage.

Clinical Manifestations—The tumor develops insidiously and when it is produced by trauma or an acute attack of pancreatitis the patient will recall that pain resulting from either of these two conditions never completely subsided. Several weeks must

elapse before the tumor grows to a size which would enable one to palpate it. The pain is not severe, is accompanied by a heavy sensation and is located chiefly in the epigastrium somewhat to the left of the midline. Anorexia is common as is also loss of weight.

The tumor presents in the left side of the epigastrium and may displace the stomach superiorly and to the right or inferi-



Fig. 5—Pancreatic cyst presenting between the stomach and colon. As is frequently the case, the mass is more demonstrable in the patient in the standing position.

orly and to the left (Fig. 5). In the former case it would present through the gastrocolic omentum and in the latter through the gastrohepatic omentum. There is not complete agreement as to which type of presentation is more frequent, indicating that there is not much difference in the incidence of the two mechanisms. The diagnosis may be confirmed by aspiration which would yield straw-colored fluid containing enzymes such as

amylase, but this procedure is *not* advocated because of possible injury to intestinal loops

Treatment—Operation is practically always indicated. One of two procedures will be utilized: (1) incision and drainage of the cyst with marsupialization or (2) excision of the cyst. Except on a few occasions, excision will be extremely difficult and quite formidable. Marsupialization is effective in obliterating the cyst if it is a true pseudocyst. However, if the lesion is a cystadenoma, marsupialization will result in a persistent sinus. Differentiation between these two types of cyst can usually be made without much difficulty by palpating the floor of the cyst. If a fungating mass is detected at this location, the cyst is usually of the adenocystic type in which case attempt should be made to excise it completely. If a persistent sinus develops following operation and resection is impractical, transplantation of the fistulous tract into the intestine usually results in cure of the fistula.

THE PANCREATICOHEPATIC SYNDROME

Recognition of a new disease commonly known as the pancreatohepatic syndrome has been made possible by the epochal work of Fisher⁷ and Allan⁸ in 1924 in which they noted that pancreatectomy in the dog led to a fatty infiltration of the liver terminating in death in two to eight months. The author is of the opinion that this disease is similar if not identical to the so-called congenital steatorrhea or cystic fibrosis of the pancreas occurring in childhood. Etiology of the disease in adults is not clearly defined but is presumably associated with gallbladder disease, duodenal ulcer, or intra-abdominal infection which might affect the pancreas. In a case observed by the author⁹ the etiology appeared to have been related to a severe gallbladder disease.

The *manifestations* of the disease are somewhat varied but a few symptoms are noted in all of the few cases reported. One of the early manifestations is passage of foul, fatty, bulky stools. Weakness and malaise are fairly constant as are also anorexia, nausea, and vomiting. Loss of weight may occur. Mild pain in the epigastrium and right upper quadrant is present and is presumably related to the disease process in the pancreas, liver, or gallbladder. Myocardial changes with fatty infiltration of a fatal character was noted in a case observed by the author but has not been described in other reports. The liver is increased in size because of the enormous fatty infiltration. Tenderness of

the abdomen may be present but is rarely pronounced. Mild diabetes frequently develops. Anemia is fairly constant. Liver function tests including the cephalin flocculation test and hip puric acid test are usually positive.

The treatment of the disease is not effective with any degree of certainty. The splendid work of Dragstedt and associates¹⁰ showing the effects of lipocain indicates that this substance should be given if available. High vitamin therapy is indicated but of more importance is the administration of choline and liver extract. The caloric intake should be slightly above the average requirement and should be high in carbohydrate and protein. Various symptomatic therapy may be instituted as indicated.

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GASTRIC HEMORRHAGE IMPLICATIONS AS TO TREATMENT*

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CAUSES OF GASTRIC HEMORRHAGE

THE vomiting of blood or the passage of large bloody, diarrheal stools is a symptom which demands expeditious and thorough investigation of the cause and prompt decision for treatment. Although a massive gastric hemorrhage presents a major catastrophe it does not justify hastily instituted measures. Nor on the other hand does a mild hematemesis permit procrastination. Every patient presenting a gastric hemorrhage deserves a complete study directed toward determining the site of bleeding and its cause. Just as hemoptysis may be the first sign of tuberculosis or other pulmonary lesions hematemesis may be the first sign of a serious gastro intestinal disease and should therefore be thoroughly studied.

The vomiting of blood is of course not conclusive evidence that the site of bleeding is in the stomach or duodenum. Thus blood that has escaped from the nasopharynx or from the lungs and has been swallowed may occasionally be vomited giving a false impression of gastro intestinal bleeding. Hematemesis may be an expression of esophageal varices in diseases of the liver and spleen or it may appear in blood dyscrasias such as splenic anemia leukemia aplastic anemia hemolytic icterus and purpura. Certain infectious diseases such as malaria yellow fever cholera scarlet fever and variola, may give rise to bleeding from the stomach. Diseases of the heart and lungs associated with failure of circulation and increased venous pressure may give rise to

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bleeding into the stomach Uremia will at times lead to loss of blood by mouth or rectum

Bleeding from the stomach may also occur occasionally following dull injury to the abdomen Injury from a bullet or a stab wound in the upper abdomen requires surgical interference without any controversy consequently the gastric hemorrhage in such cases is not a diagnostic or therapeutic problem Swallowed foreign bodies especially if sharp edged may cause bleeding Decubitus ulcers from bezoars may at times announce themselves by a gastric hemorrhage

With the exception of these rare conditions as causes of gastric hemorrhage *ulcerative lesions of the stomach or duodenum* are by far the most common causes The overwhelming predominance of gastroduodenal ulcerating lesions as cause of gastric hemorrhage is evident from reports of some of the larger clinics Thus of 668 bleeding cases studied at the Mayo Clinic¹⁴ gastroduodenal lesions were accountable in 90.5 per cent cirrhosis and splenic anemia in 5.1 per cent and all other causes in 4.4 per cent Bulmer¹⁰ reported an incidence of 88 and 90 per cent respectively of gastroduodenal lesions as the cause of hematemesis in two series of cases studied by him The incidence of bleeding due to cirrhosis in the above two groups was 4.4 and 4 per cent while that due to gastric carcinoma was 1.3 and 2.4 per cent respectively In 167 consecutive cases of gastric hemorrhage treated at Cook County Hospital within a period of a year gastroduodenal lesions were responsible for the bleeding in 89 per cent In 2 per cent the bleeding was due to cirrhosis and in the remainder to other causes From the diagnostic point of view then gastric hemorrhage presents essentially a problem of dealing with bleeding from an ulcer situated in the stomach or duodenum except in postoperative patients in whom the site of the bleeding may be at the gastrojejunal junction

CHARACTER OF THE HEMORRHAGE

In the evaluation of a gastric hemorrhage it is advisable to consider the bleeding as to amount and time We believe it a logical thing to speak of massive or of simple (small) gastric hemorrhage Obviously the two must differ in the presenting pathology symptomatology prognosis and treatment A massive hemorrhage points to an eroded large vessel possibly an artery It will also suggest the possibility of a sclerosed vessel in a chronic ulcer with much scar tissue preventing contraction of the muscular coats of the vessel At times the site of the lesion

might be contemplated from the severity of the bleeding i.e. a posterior ulcer involving the pancreas and eroding a pancreaticoduodenal artery. A slight hemorrhage points to a smaller vessel more likely with venous or capillary oozing. On the other hand, bleeding from veins or capillaries may lead to severe hemorrhage if there is present a coexistent cardiorenal disease or abnormalities of blood coagulation. Furthermore venous bleeding, when it occurs in diseases associated with gastric or esophageal varices (cirrhosis splenic anemia splenic vein thrombosis) or in blood dyscrasias may be of serious nature.

Despite some reports that the first gastric hemorrhage is the decisive factor^{11, 19} we concur in the contention of Eusterman and Balfour¹⁴ Thorstad³⁶ and others^{4, 7, 33} that patients rarely die from the first hemorrhage. Persistent bleeding however or massive hemorrhages occurring in rapid succession may terminate fatally and quite rapidly so if proper treatment is not instituted promptly.

In obtaining a history of hematemesis it is important to evaluate critically the patient's statements. Patients will often complain of vomiting blood when in reality, the dark red color of the emitted material was due to the staining of the gastric contents by a food. Furthermore the patient's story of bloody particularly black, stools must also be carefully evaluated since not infrequently the black color of the stool is due to an ingested food or to a tonic prescribed by a friend or neighbor. Often the color of the stool is just black to the patient without a differentiation as to the type of black. If it has been definitely ascertained that the patient has vomited blood or had melena if a careful check-up of the upper respiratory tract and lungs fails to show any pathologic lesions and no blood dyscrasia, infection or possibility of cirrhosis is found then the diagnosis of hemorrhage from a gastroduodenal lesion is justified even in the absence of a previous typical history of ulcer symptoms.

GASTRODUODENAL LESIONS CAUSING GASTRIC HEMORRHAGE

If the gastric hemorrhage is ascribed to a gastroduodenal lesion one must ascertain the type and if possible the location of the lesion.

Since the advent of the gastroscope it is justifiable to consider *gastritis* as an occasional cause of hematemesis. Focal changes in the gastric as well as duodenal mucosa as the cause of quite extensive hemorrhages have been described by Aschoff⁶ and Rivers³¹ among others. Gastroscoy has recently made it

possible to view such localized areas of gastritis from which oozing of blood occurs. At times actual superficial ulcerations as a source of the bleeding are noted. These lesions may account for the high percentage of negative x ray findings following gastric hemorrhage which varies from 30 to 50 per cent.

Hematemesis is much more common in patients with gastric ulcer than with *gastric carcinoma*. Nevertheless it should be emphasized that it is fallacious to assume the absence of a gastric malignancy because of a massive hemorrhage from the stomach. The massive type of hemorrhage when it occurs in a patient with carcinoma is usually due to an erosion of a large vessel and may frequently indicate the beginning of the end. A sudden massive hemorrhage too may be the first symptom of a gastric malignancy in an otherwise symptomless patient.

Benign tumors of the stomach may give rise to severe hematemesis although at times they may express themselves only by melena or persistent occult blood. The presence of a benign bleeding neoplasm as a source of hematemesis should be considered especially in young individuals who have a vague or no history of ulcer symptoms and in whom the roentgenogram shows a filling defect in the stomach.

Among other gastroduodenal lesions exclusive of ulcer which have been reported as causes of bleeding are *duodenal carcinoma*, *tuberculosis of the stomach or duodenum*, *syphilis of the stomach* and *fistulas* between the biliary and gastro intestinal tracts. In our extensive clinical experience in gastro intestinal disease we have not observed a massive gastric hemorrhage due to any of the above conditions. Syphilis of the stomach which was diagnosed in a number of patients did not produce profuse bleeding in any of them even though occult blood was found in the feces. Such lesions will therefore rarely play a role in the differential diagnosis of gastric hemorrhage.

The Predominance of Peptic Ulcer as a Cause

To repeat then the greatest percentage of gastric hemorrhage (hematemesis and melena) is caused by *peptic ulcer of the stomach or duodenum*. Of these two types ulcer of the duodenum is by far the most common cause. In some reports the ratio between duodenal and gastric bleeding ulcer is as high as 7:1. In our series it was somewhat lower. Hematemesis per se occurs more often in gastric ulcers proper since hemorrhages from duodenal ulcer often manifest themselves only as melena. How

ever massive hematemesis may appear from a duodenal ulcer especially if a large vessel at the base of the ulcer has been eroded

The factors contributing to a sudden gastric hemorrhage in a patient with chronic duodenal ulcer particularly one which has been symptomless until the bleeding are numerous. Among the more common factors productive of such a bout may be mentioned excessive physical³ or mental exertion, focal infection (teeth, etc.)³, infections of the upper respiratory tract^{1, 9}, excessive use of alcohol or tobacco³⁷ and dietary indiscretion especially when accompanied by vitamin deficiencies.^{4, 35} At the Cook County Hospital it is not uncommon to see patients admitted to the ward with the diagnosis of bleeding ulcer whose bloody vomitus is still mixed with the offending food or drink. Emotional strain^{4, 1, 16, 4, 3} seems to play a major role in provoking a gastric hemorrhage. A marked increase in the incidence of gastric hemorrhage since the beginning of the war has been reported in England.⁷⁵

As already emphasized, the diagnosis of gastric hemorrhage is not difficult if it is kept in mind that 80 per cent or more of them are due to either duodenal or gastric ulcer. The previously discussed other rarer possibilities must be considered if only to exclude them. Clinical experience in the evaluation of the condition of patients with gastric hemorrhage undoubtedly plays a large role, since laboratory data to aid in the diagnosis are often not obtainable. Thus, for example, the x-ray which at other times is of greatest help in the diagnosis of an ulcerative lesion in the gastroduodenal tract, being correct in 90 to 95 per cent of the cases, in the case of a massive hemorrhage is diagnostically valueless. It is unwise to suggest roentgenologic examination and at times impossible to submit a bleeding patient to it. No manipulation of the abdomen is permissible which markedly detracts from the value of the fluoroscopic examination.⁹ After recovery from the bleeding, roentgenography is useful in locating the exact site of the bleeding.

In patients who have previously had an operation for an ulcer of the gastroduodenal tract—particularly a gastro-enterostomy—the gastric hemorrhage may arise from the old primary ulcer of either stomach or duodenum or from a new secondary ulcer formed at the stoma. Curiously enough, the tendency toward hemorrhage is very common in patients who have had a gastric operation for a bleeding ulcer, as reported by others¹⁴ and also

possible to view such localized areas of gastritis from which oozing of blood occurs. At times actual superficial ulcerations as a source of the bleeding are noted. These lesions may account for the high percentage of negative x ray findings following gastric hemorrhage which varies from 30 to 50 per cent.

Hematemesis is much more common in patients with gastric ulcer than with *gastric carcinoma*. Nevertheless it should be emphasized that it is fallacious to assume the absence of a gastric malignancy because of a massive hemorrhage from the stomach. The massive type of hemorrhage when it occurs in a patient with carcinoma is usually due to an erosion of a large vessel and may frequently indicate the beginning of the end. A sudden massive hemorrhage too may be the first symptom of a gastric malignancy in an otherwise symptomless patient.

Benign tumors of the stomach may give rise to severe hematemesis although at times they may express themselves only by melena or persistent occult blood. The presence of a benign bleeding neoplasm as a source of hematemesis should be considered especially in young individuals who have a vague or no history of ulcer symptoms and in whom the roentgenogram shows a filling defect in the stomach.

Among other gastroduodenal lesions exclusive of ulcer which have been reported as causes of bleeding are *duodenal carcinoma*, *tuberculosis of the stomach or duodenum*, *syphilis of the stomach* and *fistulas* between the biliary and gastro intestinal tracts. In our extensive clinical experience in gastro intestinal disease we have not observed a massive gastric hemorrhage due to any of the above conditions. Syphilis of the stomach which was diagnosed in a number of patients did not produce profuse bleeding in any of them even though occult blood was found in the feces. Such lesions will therefore rarely play a role in the differential diagnosis of gastric hemorrhage.

The Predominance of Peptic Ulcer as a Cause

To repeat then the greatest percentage of gastric hemorrhage (hematemesis and melena) is caused by *peptic ulcer of the stomach or duodenum*. Of these two types ulcer of the duodenum is by far the most common cause. In some reports the ratio between duodenal and gastric bleeding ulcer is as high as 7:1. In our series it was somewhat lower. Hematemesis per se occurs more often in gastric ulcers proper since hemorrhages from duodenal ulcer often manifest themselves only as melena. How

ever, massive hematemesis may appear from a duodenal ulcer especially if a large vessel at the base of the ulcer has been eroded

The factors contributing to a sudden gastric hemorrhage in a patient with chronic duodenal ulcer, particularly one which has been symptomless until the bleeding are numerous. Among the more common factors productive of such a bout may be mentioned excessive physical³ or mental exertion, focal infection (teeth etc.)³ infections of the upper respiratory tract^{1 9} excessive use of alcohol or tobacco³⁷ and dietary indiscretion, especially when accompanied by vitamin deficiencies.^{4 35} At the Cook County Hospital it is not uncommon to see patients admitted to the ward with the diagnosis of bleeding ulcer whose bloody vomitus is still mixed with the offending food or drink. Emotional strain^{4 1 10 4 35} seems to play a major role in provoking a gastric hemorrhage. A marked increase in the incidence of gastric hemorrhage since the beginning of the war has been reported in England.⁵

As already emphasized, the diagnosis of gastric hemorrhage is not difficult if it is kept in mind that 80 per cent or more of them are due to either duodenal or gastric ulcer. The previously discussed other rarer possibilities must be considered if only to exclude them. Clinical experience in the evaluation of the condition of patients with gastric hemorrhage undoubtedly plays a large role since laboratory data to aid in the diagnosis are often not obtainable. Thus for example the x-ray which at other times is of greatest help in the diagnosis of an ulcerative lesion in the gastroduodenal tract being correct in 90 to 95 per cent of the cases in the case of a massive hemorrhage is diagnostically valueless. It is unwise to suggest roentgenologic examination and at times impossible to submit a bleeding patient to it. No manipulation of the abdomen is permissible which markedly detracts from the value of the fluoroscopic examination.⁹ After recovery from the bleeding roentgenography is useful in locating the exact site of the bleeding.

In patients who have previously had an operation for an ulcer of the gastroduodenal tract—particularly a gastro enterostomy—the gastric hemorrhage may arise from the old primary ulcer of either stomach or duodenum or from a new secondary ulcer formed at the stoma. Curiously enough, the tendency toward hemorrhage is very common in patients who have had a gastric operation for a bleeding ulcer as reported by others¹⁴ and also

seen in our material. Thus within the period of one year ten patients (7 per cent) of those admitted with bleeding ulcer had had some type of gastric surgery (not resection) within three months to sixteen years of the present hematemesis. Three of these had to undergo a second operation. These and similar observations in many different clinics are in no small way responsible for the present hostile attitude on the part of the gastroenterologist towards gastroenterostomy as an operative procedure in bleeding ulcer. Not only is there a tendency towards bleeding by the primary ulcer in patients with gastroenterostomy but the secondary stomal ulcers also have a marked tendency toward bleeding.

IMMEDIATE TREATMENT

Having established that the bleeding is due to a gastroduodenal lesion appropriate steps must be taken immediately toward vigorous prosecution of the treatment. There are certain fundamental steps to be taken in every case of bleeding regardless of what other procedures will be necessary six, twelve, twenty-four hours or even several days later. It is only rarely that one can decide upon the whole management of the case at the instant one sees the patient. A decision as to whether medical treatment should continue or whether it should be supplemented by surgical intervention may have to await the patient's response to the initial treatment. Even if surgical intervention is decided upon the patient needs certain preparations which after all constitute medical treatment. In the management of a patient with bleeding ulcer the surgeon and internist must cooperate.

General Measures

The patient with gastric hemorrhage must be at complete bed rest. Anxiety, apprehension, restlessness or pain if present should be controlled by morphine sulfate given every four to six hours as needed. Because of the anemia and shock in some cases $\frac{1}{8}$ to $\frac{1}{6}$ grain—instead of $\frac{1}{4}$ grain—of morphine sulfate with $\frac{1}{160}$ grain of atropine sulfate may suffice. Retching may have to be controlled by aspiration of the stomach preferably through a Levin tube. Gastric lavage as suggested by some is rarely done in our clinic. An ice bag to the abdomen may be used but its value is problematic. The blood pressure and pulse should be determined and checked at frequent intervals depending on the general appearance and demeanor of the patient.

The hemoglobin and red blood count should be estimated and likewise the patient's blood group determined. In the absence of signs of shock fluids, preferably physiologic saline and dextrose mixture may be given slowly by hypodermoclysis for combating thirst and dehydration. We do not use rectal drip ordinarily, but occasionally do give small pieces of ice with instructions to the patient to spit out the fluid. All fluids and food by mouth are, of course withheld.

Blood Transfusion

If shock from loss of blood is present, it should be combated by the administration of blood. In bleeding conditions, blood is the only rational substitute. Plasma can be used but only as a preliminary measure until whole blood is obtained. The indications for blood transfusion in patients with gastric hemorrhage vary in different clinics. Moreover, there still exists a small minority of practitioners who believe that transfusion is contra-indicated because it may raise the blood pressure, with consequent dislodgement of the clot and recurrence of the bleeding despite the fact that proof for this theoretic objection has never been produced. Others believe in small transfusions only.^{1, 13, 19, 34} On the other hand there is much evidence to support the justification and advantages of blood transfusions in gastric hemorrhage.^{1, 3, 33}

As a rule, blood transfusion is indicated when the patient appears in shock, as manifested by the syndrome of marbled air hunger, rapid pulse, low systolic blood pressure (below 90 mm of mercury), restlessness which at times may go into slight delirium, reduced erythrocyte count (2-3 000 000) and hemoglobin (40 to 50 per cent). Sweating, cold clammy skin and pale cyanosis are other signs of more severe shock.

The amount of whole blood given depends on the presenting signs. In some patients with gastric hemorrhage 500 cc or more may have to be given before signs of improvement appear. The amount necessary can be determined from the patient's condition (pulse, blood pressure, hemoglobin, red blood count, hematocrit reading and so forth). We do not feel that 200 to 300 cc quantities are preferable to 500 cc given as a slow intravenous infusion. The advocates of the small transfusion feel that the low blood pressure is an excellent natural mechanism for promoting clot formation and should not be disturbed (i.e. raised) by large transfusions.¹ Others, on the contrary, hold that blood

transfusions exert a hemostatic and coagulative action and that the danger of blowing out a clot by a raised blood pressure is nonexistent^{1 3 33} From our data we are in complete agreement with the latter group and believe that sufficient blood should be given these patients to bring them out of shock. In this connection Allen's¹ statement seems pertinent. We have seen patients die from the lack of blood but in no instance have we seen transfusions responsible for fatal hemorrhage.

Obviously the cases with bleeding to an extent that transfusions are required are the ones in which future management will have to be decided within a comparatively short time. It is clear that in spite of an unlimited blood supply as we have from the blood bank it is irrational to continue transfusions and conservative treatment in the face of progressive gastric bleeding as manifested by persistent hematemesis continued rapid pulse low or falling blood pressure and falling red blood count and hemoglobin values. Hence if within one to twelve hours after or during transfusion the symptoms of shock not only fail to improve or as it occasionally happens become more marked the patient should be immediately operated upon as it is certain that the bleeding takes place from an eroded large vessel (Graham's transfusion test¹⁷).

SURGICAL TREATMENT

Indications for Immediate Operation

From the preceding discussion of the principles of general management in gastric hemorrhage it is easy to see how the surgeon enters into the treatment of bleeding ulcer. Most surgeons justifiably avoid operation on a patient with sudden massive gastric hemorrhage. We believe however from experience gained in our clinic with patients who bleed continuously in spite of adequate management as does occur in a small number of instances that for them surgery within a matter of hours after the onset of the bleeding is required otherwise they will be lost. When death from hemorrhage occurs the question must always arise as to whether or not the fatal outcome could have been avoided by prompt operation. This is especially true if at necropsy open vessels are found in the ulcer.

Indications for Intermediate or Elective Surgery

Aside from these infrequent instances when an immediate operation for relief of gastric hemorrhage is necessary most

surgeons believe contrary to Finsterer¹⁵ that gastric hemorrhage should not be treated by prompt operation. There are at present fairly well recognized indications for intermediate or elective surgery in cases with bleeding gastric or duodenal ulcer. In the elaboration of the indications for surgery, certain presenting facts must be evaluated. How severe is the bleeding? Is it a massive hemorrhage or a small one with little risk? Is it a first hemorrhage or a recurrent one? (Recurrent hemorrhages are associated with a higher mortality rate^{7 8 9}.) Is the patient elderly or a younger person? (The mortality rate is higher in patients above the age of 45 years^{3 1 18 39}.) Is he in good general condition? Has he been suffering from other ulcer symptoms? Has he other ulcer complications? What are his risks of surgical intervention? All these questions must be carefully answered because it is only when surgery promises better results than nonsurgical treatment that one is justified to advise it.

The indications for surgery in gastric hemorrhage cannot be based purely on a comparison of statistical data regarding mortality on medical and surgical management. These vary markedly between different clinics.^{9 1} Too often such data compare results in terminal cases surgically treated with those in the average case. It is not right to ascribe death to surgical intervention when a patient is treated medically until he is almost completely exsanguinated before surgery is finally decided upon. The marked discrepancy in mortality percentage between surgical and medical treatment results from the fact that most medical failures come into the column of surgical mortality. These data cause a great deal of indecision among surgeons as to the accepted conditions and indications for surgery. Hence only one's own experience with bleeding ulcers will enable one to decide for or against operation in a given case.

In the past decade certain indications and contraindications for surgery in bleeding ulcer have become clarified and with some modifications are usually accepted by most gastric surgeons. Thus at the Mayo Clinic first massive gastric hemorrhages are usually treated medically. However when a hemorrhage from an ulcer recurs before the patient has fully recovered from his initial hemorrhage operation is performed. Graham¹⁷ believes that a massive hemorrhage in a patient over fifty who has a hemoglobin level below 50 per cent should make one seriously consider operation. Lahey³ among others believes surgery is indicated only when medical therapy has

failed decisively or if patients have other associated complications which in themselves are definite surgical indications

Ranlin and his associates³⁰ demand that the following conditions be present before surgery is advised (1) a massive hemorrhage occurring in a known peptic ulcer patient over fifty years of age (2) a massive hemorrhage occurring in a known peptic ulcer of long standing which has failed to respond to careful continuous medical treatment (3) a massive hemorrhage following one or more previous episodes of severe bleeding from a peptic ulcer and (4) when a massive hemorrhage from a known ulcer of long standing or in an arterio-sclerotic patient fails to respond to one or more transfusions but shows evidence of continuous or repeated bleeding

Holman¹⁸ considers indications for surgery to be (1) an immediate recurrent or persistent bleeding after complete bed rest and (2) a hemorrhage beginning while the patient is receiving adequate medical treatment in the hospital Meulengracht²⁷ however thinks that with a one to two per cent mortality from bleeding ulcer on his dietary regimen he is not called upon to decide when an operation should be performed Unfortunately Meulengracht's results could not be duplicated either in other clinics or by us so that surgery must still be considered at times in the therapy of bleeding ulcer

We operate in all cases of recurrent massive hemorrhage occurring while the patient is on an adequate medical regimen particularly if he is over forty years of age as soon as he recovers from the initial shock and has been carefully prepared by transfusions for the operative procedure Secondly we advise operation in all ulcer patients who in spite of a careful medical regimen have gastric hemorrhage or melena at certain intervals Thirdly we operate upon all patients with even mild degrees of bleeding if they give definite evidence of other ulcer complications such as pyloric obstruction large gastric ulcer or intractable ulcer pain

Choice of Operation

Surgical intervention in gastric hemorrhage has for its aim the stopping of the present bleeding or as is most often the case the prevention of another severe hemorrhage This can best be accomplished by excision of the ulcer bearing and ulcer stimulating parts i e gastric resection Some however still frown upon the latter as a procedure with too great risk for

a bleeding patient. Nevertheless, the results of the past few years in various clinics, including our own are ample proof of the fact that gastric resection with removal of the ulcer site is the only logical procedure and that it need not be accompanied by a prohibitively high mortality.⁸ Only in instances in which gastric resection is technically impossible may other procedures have to be applied. Local excision or local destruction of the ulcer or a transfixion operation at times may have to be done instead of a gastric resection.

Technical Considerations

The operative technic in cases of gastric hemorrhage depends upon the individual surgeon. We have for the past few years followed the surgical procedure outlined below.

Nupercaine spinal anesthesia is uniformly used because of the better relaxation afforded, the absence of a period of excitement during the induction and the decreased incidence of post-operative complications encountered following its use. In spite of the possible theoretical contraindication to spinal anesthesia because of the low blood pressure in patients with bleeding ulcer we have used it routinely without untoward results. If necessary blood pressure can be raised promptly by injection of ephedrine and kept up by a more rapid transfusion of blood. Frequently a low blood pressure is intentionally maintained until the bleeding vessel is found and ligated.

After opening the abdomen the peritoneal cavity is quickly explored for the presence of other pathologic conditions and then the stomach and duodenum are examined to ascertain the cause of the bleeding. An opening is made through the gastro-hepatic omentum and the posterior wall of the stomach is freed from any adhesions that may be present. The greater curvature is freed upward and downward by grasping and cutting successive portions of the gastrocolic omentum between Kelly forceps. These are carefully tied with catgut. A similar procedure is used along the lesser curvature with special care to the blood vessels until the portion of the stomach and duodenum which is to be resected has been freed.

Babcock forceps are then placed on the tissue above and below the duodenum and a Payr clamp is placed across the portion to be resected. The duodenum is cut across with the knife just distal to this Payr clamp (Fig 6 A). This permits an open exploration of the duodenum.

It has been our experience that one finds a large ulcer penetrating into the pancreatic bed in a great majority of these cases. In operations for bleeding carcinoma or gastric ulcers the classical closure of the duodenum can be accomplished without

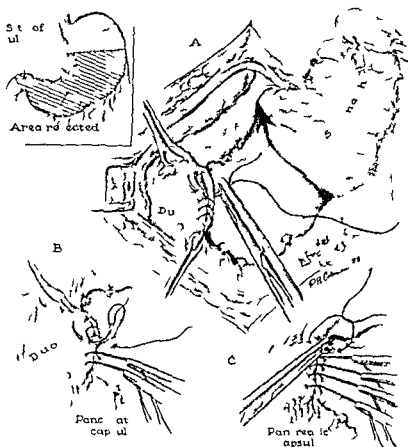


Fig 6—The various steps in closure of the duodenal stump. A Interrupted catgut sutures are placed so as to catch all of the layers of the posterior and anterior walls of the duodenal stump. Note that Babcock forceps are placed on tissues above and below the duodenum and not on the duodenum proper. B C Embedding of the duodenal stump below the pancreatic capsule by means of interrupted vic sutures. In C is shown the tying in of the lesser omentum and the ligated branches of the gastric vessel to reinforce the upper angle.

difficulty. However, in these bleeding ulcers the technic of closure is quite difficult. In a considerable number of instances we find during operation large ulcer bases present in which an open vessel (pancreaticoduodenal) is spurting blood. At times

it is necessary to transfix these vessels with catgut stitches through the bed of the ulcer. In others, because of the friability of the vessel a piece of omentum or muscle tissue is utilized for transfixation

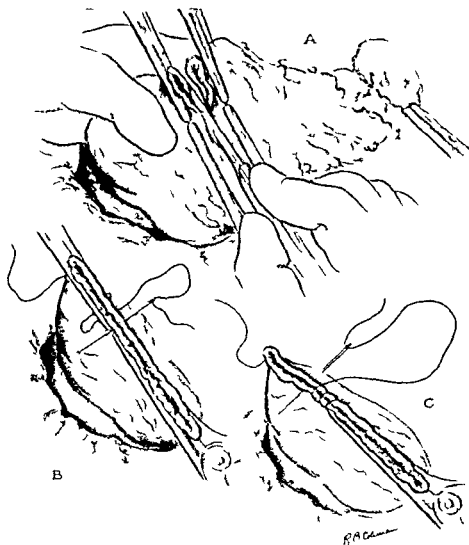


Fig 7—The various steps in gastric resection according to our modification of the Hofmeister technic *A* Stomach clamped with Payr clamps. Incision made flush with proximal two clamps *B* Through and through catgut sutures are applied beneath clamp *C* Clamp is removed and over and-over sutures are applied and tied

As a rule the duodenum is closed by interrupted catgut sutures which are so placed as to catch all the layers of the posterior wall and then those of the anterior wall. The end sutures at the greater and lesser curvatures are held with forceps for fixation and then inverted by a half purse string suture of catgut so as to close the ends well. Interrupted wire sutures are

then placed from the pancreatic capsule to the anterior duodenum just beyond the catgut sutures previously placed so as to bury the duodenal stump in the head of the pancreas and under the pancreatic capsule (Fig 6 B, C) Any available omental tissue is then tied over the closed stump for additional protec

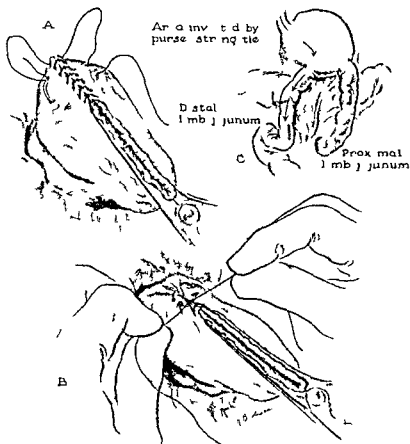


Fig 8—Detail of the modification of the Hofmeister gastric resection A Interrupted catgut suture for the closed part of the stomach with the half-purse string in place B Closure of the half-purse string with the burying of the corner of the stump C Schematic drawing of the final results

tion Too close attention to the detail of closure of the duodenum cannot be paid Sulfanilamide powder is placed about the duodenal closure

The gastric resection is done according to the Hofmeister technique modified by one of us (KAM) (Fig 7 A B C) The modification consists of burying the lesser curvature of the

stomach by means of a half purse string suture (Fig 8 A) and the lower border of the stomach not used for the stoma is thus invaginated after first being carefully closed (Fig 8 B, C) The final result is then similar to a Schumacher type of closure Thus the dangerous corner on the lesser curvature is avoided We also prefer an antecolic to a retrocolic anastomosis, as the former type is safer Should any complications arise and reoperation become necessary it can be done more expeditiously in the presence of an antecolic anastomosis Occasionally a high posterior Polya type resection is done It is important that the proximal loop of the jejunum be of sufficient length so that retraction of the stomach to the left will not pull on the anastomosis

We believe that postoperative complications such as persistent vomiting due to poor functioning of the stoma are rarely due to edema brought on by a hypoproteinemia as thought by some but most often to faults in technic Thus tight suturing of the proximal loop produces a partially closed loop If a completely closed loop results it leads to a very stormy postoperative course and may blow out the duodenal stump with resulting fatal peritonitis If the distal loop is too tightly closed signs of a high intestinal obstruction occur

We also prefer to do a high gastric resection with removal of at least three fourths or four fifths of the stomach

The patency of the stoma into each loop of the jejunum is carefully checked before the abdomen is closed Sulfanilamide powder is placed around the anastomosis

Closure of the abdomen is carried out with the same care that is paid to the anastomosis the peritoneum being sutured with interrupted catgut the fascia with interrupted wire and the skin with interrupted silk

Postoperatively the patient receives blood or plasma fluids and injectable vitamins Levin suction is continued for forty-eight to seventy two hours Attention is given to the peripheral circulation and the patients are permitted to get out of bed on the second to the fourth day Getting patients up early prevents pulmonary and vascular complications and is helpful for the morale of the patient

Results

The results of our therapeutic procedures in cases of bleeding ulcer have been favorable considering the material with which we are working When it is realized that the majority of pa

tients in this hospital are *a priori* undernourished it is easy to see how the existence of a chronic disease such as peptic ulcer will result in their having additional deficiencies. Indeed many of our patients with bleeding ulcers enter with very low levels of vitamin C low levels of vitamin A and frequently with hypoproteinemia. In spite of these handicaps radical gastric surgery has been possible in some of them with a fairly low mortality.



Fig 9—X ray of patient who had a modified Hofmeister type of gastric resection as shown in Figures 6, 7 and 8. Note that the stoma seems to be completely across the lower end of the stomach.

by giving careful preoperative and postoperative care with special attention to frequent blood transfusions. Appropriate preoperative and postoperative management is just as important as the technical procedure and good anesthesia. In our cases we have attempted to maintain the water and mineral balance of patients and to replenish their vitamins, proteins and blood, the latter being a good substance also for increasing the plasma proteins.

Within the past year twenty nine patients who entered the Cook County Hospital with bleeding ulcers were operated upon within two hours to seventy three days from the time of their admission. As stated previously there are rare instances when operation must be done within hours to save the patient's life. Three patients were operated upon within three hours, three within twenty four hours, one within thirty six hours, one within forty eight hours and the remaining twenty three within four to seventy three days. There were two deaths, one from uremia in a patient operated upon twenty hours after admission and the other from recurrent hemorrhage (Case I) in a patient operated upon twenty hours after admission. The two patients operated on within two and the one within three hours (Case II) made uneventful recoveries. In the other patients who came to operation the medical regimen had failed to relieve the symptoms and the indications for surgery developed at various intervals after the time of admission. All recovered following surgical intervention.

CASE REPORTS

CASE I—H. M., a white man, thirty five years of age, had had symptoms of peptic ulcer since 1932. In 1935 a posterior gastrojejunostomy was made elsewhere. In August 1941 he was treated for bleeding ulcer by diet and alkali therapy in Cook County Hospital and did moderately well. On November 8, 1941, at 4:00 P. M. he had a severe hematemesis (1 pint of blood) and melena. He vomited blood again on entrance to the hospital at 5:00 P. M.

On admission the patient's pulse was 120, his blood pressure 67/0 and he was pale and apprehensive. The hemoglobin was 35 per cent and the red blood cell count 1,750,000. He was immediately given 500 cc. of citrated blood and two hours later his blood pressure had risen to 84/40 and his pulse had dropped to 104. During the night he vomited small amounts of coffee ground material and his blood pressure began to drop. Five hundred cubic centimeters of blood was given at 4:00 A. M. but at 9:30 A. M. the blood pressure was 52/0 and the hemoglobin thirty three per cent.

The patient was taken to the operating room eighteen hours after entrance. A laparotomy was performed under spinal anesthesia using 15 cc. of nupercaine (1:1500 solution) with the addition of 50 mg. of ephedrine and 12 cc. of a 2.5 per cent sodium pentothal solution (50 mg.) for closure. Blood was given during the operation. The blood pressure was 60/0 at start and 104/40 at the termination of the operation. A sclerosed vessel spurting blood in a marginal ulcer the size of a dime on the posterior edge of the anastomosis

was found to be the cause of a hemorrhage. A high gastric resection and an antecolic gastrojejunostomy was done.

Although the patient received 2000 cc of blood within the first twenty four hours. He received 500 cc blood each day on the second third and fourth postoperative days. On the eighth postoperative day his hemoglobin was 75 per cent and the red blood cell count 3 240 000 and he was up and about. That night he developed epigastric pain and shortly thereafter he had a profuse hematemesis and became cold and clammy. A transfusion of 1000 cc of blood was immediately started. The patient however continued to vomit intermittently varying quantities (200 to 500 cc) of blood his pressure began to drop and his pulse to rise. Gastric lavage with ice water and introduction of adrenalin into the stomach were without effect as was also another blood transfusion. The patient expired within twenty one hours after the onset of the bleeding. No necropsy was obtained.

The finding at operation of a spurting blood vessel makes it clear why this patient had to be operated during a massive gastric hemorrhage. The fact that the patient ultimately succumbed to hematemesis does not speak against surgery in such a case. This case proves that a severely bleeding patient can be successfully operated upon during the stage of bleeding if given sufficient blood and that surgery is the only hemostatic agent in such a patient. The cause of the recurrent hemorrhage and of the ensuing death is problematic since no postmortem examination was done.

CASE II—N. C. a fifty five year old white woman had been having ulcer symptoms for the past five years. Pains were usually relieved by alkali. On the day before entrance into the hospital she experienced severe pain associated with the sudden vomiting of about a pint of blood. She continued to vomit intermittently small amounts of blood until the following day when she again had a more profuse hemorrhage. Following this one she entered the Cook County Hospital.

On entrance the patient appeared quite restless and pale her hemoglobin was 50 per cent and the red blood cell count was 3 000 000. The blood pressure was 130/80 the pulse 102.

Because of the history of continuous vomiting of blood a dropping blood pressure accompanied by a rising pulse rate and the poor appearance of the patient clinically (in spite of the transfusion of 500 cc of citrated blood) a laparotomy was performed under spinal anesthesia (15 cc of 1 1500 nupercaine solution) three hours after admission. At operation a large duodenal ulcer on the

posterior wall of the duodenum was found. At the base of the ulcer there protruded a small sclerosed artery from which blood spurted freely with each systole. A high posterior Polya type gastric resection was done removing the duodenal ulcer and about four fifths of the stomach. The patient received 1000 cc of blood during the operation and 500 cc daily for the next four days. Except for a mild bronchopneumonia on the fifth postoperative day which was treated with sulfathiazole she made an uneventful recovery and left the hospital on the seventeenth day after operation.

In this patient the findings at operation amply justified the immediate surgical intervention since it is clear that no medical management could possibly have stopped bleeding from that vessel. This is proved by the fact that the patient bled continuously for nearly forty eight hours after the first massive hemorrhage. The fact that her blood count on entrance to the hospital was comparatively good was due more to the state of dehydration of the patient and could not be taken as a criterion of her actual blood picture. The age of this patient and her general clinical appearance seemed to us to demand early surgical intervention rather than delay and continuation of medical management.

As in the first case cited and in numerous other instances we have found that the initial blood count should not be a deterrent factor in considering necessary early surgical intervention provided blood is started immediately and continued during the operation.

SUMMARY

1 Gastric hemorrhage is in most instances (about 90 per cent) due to an ulcerative lesion of the gastroduodenal tract; it is more often due to a duodenal ulcer.

2 The patient with a gastric hemorrhage must be treated promptly and intensively.

3 Blood transfusion should be given when indicated since patients rarely die from receiving too much blood but quite often do so from not getting sufficient blood.

4 The clinician and the surgeon should cooperate closely in each case of a massive gastric hemorrhage as surgical intervention may be necessary within hours after the onset of the severe bleeding.

5 There are definite indications for surgical intervention in cases of bleeding ulcer; these should not be interpreted with too great restrictions.

6 Surgical intervention should be considered more seriously as a possible step in the treatment of bleeding ulcer in patients above forty five in those with recurrent hemorrhages and in those with ulcers which bleed now and then on a strict medical regimen.

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PEPTIC ULCER

JOHN VAN PROHASKA M.D.

ETIOLOGY

WITHIN recent years most of the dominant thoughts dealing with the various phases of peptic ulcer have been more or less standardized in the minds of clinicians. This useful and workable crystallization of opinion has occurred in spite of the fact that the investigator in the etiology of peptic ulcer still looks for more and more evidence for the support of his theory. By careful research overwhelming evidence has been accumulated to show that the presence of gastric hydrochloric acid is essential in the production of peptic ulcer. If we had corresponding evidence to show how the gastric hydrochloric acid initiates the formation of the duodenal or gastric ulcers and if we knew the anatomical parts and the physiological behavior employed the problem of the etiology would be solved.

Many attempts have been made to bridge this gap. The clinician has supplied an important observation on the behavior pattern of the ulcer patients. There is no doubt that the majority of ulcer patients present a personality pattern which delimits them somewhat from the average normal. The patient is usually thin, high strung, nervous, restless, a worrying, hard working individual. This of course fails to name anatomical pathways and physiological behavior and therefore cannot fully explain the initiation and the perpetuation of a peptic ulcer. As this paper deals mainly with the clinical surgical aspect, I shall not dwell on the older theories which have been discredited by the weight of modern literature.

A few years ago there appeared in the literature a theory that peptic ulcer may be caused by the deficiency of certain amino acids, mainly histidine.¹ This contention was supported by only a few and poorly controlled experiments. I prepared six dogs with complete gastric pouches. The nerve supply to these pouches was left uninterrupted as described by Lester R. Dragstedt.² The secretions from these gastric pouches were studied daily for two weeks to secure a control level. There

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after, each dog was given a daily injection of histidine for twenty one days. These injections produced no effect on the amount of gastric juice secreted per day, nor on the degree of gastric acidity. Ulcers could be produced in these pouches at will during the course of these injections by clamping off the cannula and letting the pure unbound juice accumulate for short periods of time within the pouch.

DIAGNOSIS

The diagnosis of peptic ulcer usually is not difficult, the best single evidence is a typical history which may or may not be confirmed by x ray study. A greater number of ulcers are detected by x ray when the mucosal pattern is studied. Some ulcers are silent producing no symptoms until they cause stenosis, hemorrhage or rupture. The large gastric ulcers present an interesting diagnostic problem because they must be differentiated from early ulcerating carcinomas. In these instances gastroscopic examination is of considerable help. However I have been guided mainly by response to ulcer management and repeated x ray studies. When the course of observation fails to erase the suspicion that the ulcer under consideration is carcinoma, subtotal gastric resection is recommended to the patient.

The most important surgical factor is the delimitation of the surgical from the nonsurgical ulcers. It must be remembered however that the individual case must be evaluated in the light of its own criteria rather than by the consultation with a set of rules.

RUPTURED PEPTIC ULCER

Diagnosis

The ruptured duodenal or gastric ulcers command an absolute surgical emergency. The diagnosis is not difficult but may be complicated by the absence of previous ulcer history, by history of injury, or by failure to detect gas under the diaphragms on x ray examination. Let us illustrate a case presenting a complicated history.

CASE I—O S a white male laborer aged forty six years was brought to Mercy Hospital at 9 00 A M. The referring physician and the industrial surgeon gave the following account of this patient's history. That morning while pushing a wheelbarrow loaded with three heavy barrels up an incline the patient slipped and the barrels rolled onto his abdomen. The diagnosis was intra abdo

minal crushing injury I saw the patient at 5 00 P M A survey of his abdomen disclosed no evidence of external injury With some difficulty a new history was elicited as follows The patient experienced a sudden excruciating pain in the abdomen while he was pushing the heavily loaded wheelbarrow up the incline It was because of this pain that he let go and the barrels rolled off There was no previous history of ulcer

On examination the patient had generalized abdominal rigidity shoulder pain pulse of 120 respiration shallow 30 per minute temperature 101° F white cell count 27 000 and urine negative The x ray showed a small amount of gas under both diaphragms A diagnosis of ruptured peptic ulcer was made The patient was operated upon eleven hours after the accident At operation a typical ruptured ulcer on the posterior duodenal wall was found The convalescence was uneventful except for a small subcutaneous hematoma

Treatment

Patients with ruptured peptic ulcers entering the service of the author at the Chicago Memorial Hospital have been treated as follows The waiting period between entry to the hospital and the actual delivery of the patient to the operating room is utilized for the introduction of normal salt solution intravenously Often from 500 to 1000 cc of normal salt solution is given before the operating room is ready This is then continued during the operation as needed Wangenstein suction is introduced and the stomach aspirated without lavage

General anesthesia using ethylene gas or cyclopropane or occasionally spinal anesthesia is employed A midline incision is made from xiphoid to umbilicus Upon opening the peritoneum a thorough debridement is made by means of suction The gastric contents within the peritoneal cavity are evacuated and all visible particulate matter is removed One linen purse string suture is placed and tied so that when it sloughs off it sloughs into the lumen of the viscus This is then covered by a row of chromic catgut sutures on an atraumatic needle and this in turn is well covered by a patch of omentum Five grams of crystalline sulfanilamide is sprinkled evenly into the peritoneal cavity and a small quantity of the crystals is saved for the wound

Upon returning the patient to his room continuous gastric suction is reinstituted and continued for two or three days During this time the mineral and fluid balance is maintained by

replacing the chlorides lost by normal salt solution or Ringer's solution, and restoring the fluids by giving the balance as 5 per cent glucose in distilled water. In the average case the patient receives 1000 cc of normal salt solution and 2500 cc of 5 per cent glucose in distilled water by vein daily for two days. These amounts are then tapered off as the fluid intake by mouth increases. We have not found it necessary to continue sulfonamides by mouth or parenterally after the initial intraperitoneal dose.

During the past two years nine patients with ruptured peptic ulcers have been handled at the Chicago Memorial Hospital; the youngest was twenty three and the oldest sixty years of age. The shortest time before surgical treatment was four hours; the longest eleven hours. Eight patients were male, one female. Eight had duodenal ulcers and one a gastric ulcer. There was no mortality. The average stay in the hospital was fourteen days. There is no doubt that the use of sulfonamides intraperitoneally lessened the mortality and morbidity in the case of this small series.

BLEEDING PEPTIC ULCER

It is the surgeon who must recognize the value and importance of conservative treatment in cases of bleeding peptic ulcer. This is true because death seldom occurs from bleeding gastric or duodenal ulcers in young or middle aged patients. Patients beyond forty-five years of age have a tendency to bleed over longer periods of time and it is in this group that the greatest number of deaths occur under conservative as well as under surgical management. The surgeon in cooperation with the internist decides which patient is to be operated upon. Ideally, operation is done only in those cases in which the surgical procedure is necessary to save life. This necessity is not always easily determined. If surgery is not performed, the patient may die from sudden increase of the hemorrhage; if performed, the surgical procedure may be enough to tip the scale towards death. One therefore must draw upon experience and take into consideration the behavior of the individual case before applying final judgment.

Peptic Ulcer with Severe Uncontrollable Bleeding

The criterion which compels the surgeon to operate on a bleeding peptic ulcer during the act of hemorrhage is above all a severe uncontrollable hemorrhage in which further loss of

blood would threaten the life of the patient. Fortunately this is a rare occurrence. A severe hemorrhage must be carefully differentiated from a hemorrhage of esophageal varices. The success of the operation depends upon the adequate and prompt replacement of the blood lost by transfusion. We have given as much as 2000 cc. of blood in twenty four hours in cases of massive hemorrhages.

The operative procedure depends upon the physical state of the patient. If shock is alleviated by an adequate blood transfusion during the entire course of the operation and if the subtotal gastric resection removes the bleeding point then that is the procedure of choice. If however the ulcer is situated in that portion of the duodenum which cannot be incorporated in the resection and if because of the physical state of the patient the operation must be terminated it is best to do a simple ligation of the bleeding point. The subtotal gastric resection may be done at a later date. I believe that a greater number of patients would be saved if during operation larger amounts of blood were given by transfusion.

Peptic Ulcer with Steady Slow but Dangerous Bleeding

The second type of bleeding peptic ulcer that comes to surgery is that with steady slow but dangerous bleeding which does not subside on good ulcer management i. e. continued adequate alkalization absolute bed rest and sedation. This type of hemorrhage occurs almost entirely in the older group of patients. It is believed to be due to the fact that the sclerotic vessels do not retract and thus continue to bleed freely. This type of bleeding is well illustrated in the following case.

CASE II—H. H. a white man aged fifty nine years complained that two weeks prior to admission to the Chicago Memorial Hospital he felt unusually weak and dizzy. On the day of admission he vomited coffee ground material and fainted while walking to the mailbox. The patient had noted tarry stools for about three weeks. He had had vague abdominal symptoms for many years with long periods of remission. His family physician treated him for a chronic gallbladder disease.

Upon examination the patient presented a picture of a slight poorly nourished male with marked pallor. The pulse was 90 temperature 98.6 F. red cell count 2,400,000 hemoglobin 40 per cent white cell count 8,600 and blood pressure 120/80. The stool showed 4 plus occult blood.

A diagnosis of bleeding peptic ulcer was made and the patient was placed on a complete ulcer management. He continued to bleed as evidenced by tarry stools and a daily deficit in his erythrocyte count. At the end of one week the red cell count was 2 000 000 and hemoglobin 40 per cent. The patient was very weak and had difficulty in breathing. He was given 600 cc of citrated blood by transfusion and showed a remarkable improvement for the next three days. His blood count was 2 600 000 and hemoglobin 50 per cent. One week after transfusion his blood count was again 2 000 000 and hemoglobin 40 per cent. He became very weak and again was transfused.

Three weeks after admission to the hospital the patient still continued to bleed down to dangerous levels. Considering that he had been bleeding for at least two weeks prior to entry to the hospital or a total of five weeks he was given several blood transfusions and a subtotal gastric resection was then performed. At operation two bleeding duodenal ulcers were found on the posterior wall. It was possible to include both ulcers in the gastric resection although the ulcers were so far in the duodenum that in the process of resection they were destroyed by the Payr's clamp. The convalescence was uneventful.

Peptic Ulcer with Repeated Episodes of Bleeding

The ulcer that causes repeated hemorrhages constitutes another group which deserves careful surgical consideration. In this group the greatest attention must be paid to the problem of the individual patient because almost always these repeated episodes of bleeding mark the patient's failure to cooperate in a program of ulcer management. If the patient is either unwilling or unable to follow a sensible program it may be best to advise a subtotal gastric resection after the termination of one of his bleeding episodes. We may illustrate this problem by the following case.

CASE III—M. T., a white housewife aged thirty-two years, the mother of four children, entered the Chicago Memorial Hospital with a moderately severe bleeding. She stated that this was her fourth major bleeding episode in four years. In each instance she was hospitalized from two to six weeks. During this four-year period she was always on some sort of ulcer management. She had been told that she had four duodenal ulcers.

Her red cell count was 2 850 000, hemoglobin 52 per cent, and blood pressure 105/70. X-ray examination revealed a large ulcer on the lesser curvature of the stomach.

Under a complete ulcer management the patient continued to have tarry stools for ten days following which she made a prompt recovery. Three weeks later she was operated upon. A large ulcer on the lesser curvature of the stomach was found. This ulcer was perforating into the retrogastric tissue. A subtotal gastric resection with posterior Polya type of anastomosis was done. Her recovery was uneventful. The patient has had no symptoms for three years.

PEPTIC ULCER THAT DOES NOT RESPOND TO MEDICAL MANAGEMENT

The last group that I wish to include in this surgical consideration is one which has been referred to as the peptic ulcer that does not respond to ulcer management. It would be preferable to call this group the peptic ulcer with extension to other organs such as the gallbladder or the pancreas. Almost invariably when good ulcer management under hospital supervision fails to relieve the symptoms in a reasonable time one finds an extension of the disease into either the gallbladder, the pancreas or at least into the transverse mesocolon or the retrogastric tissue. These are large penetrating ulcers, duodenal or gastric. They often give atypical symptoms of constant pain over the gallbladder area or boring pain deep in the epigastrium, not always relieved by milk and soda. The following are typical examples of peptic ulcer with extension to other organs.

CASE IV—W. H., a male Negro, aged sixty years, a diabetic, entered the Chicago Memorial Hospital with the diagnosis of acute gallbladder disease. He gave a history of long standing vague upper abdominal distress, particularly after eating. The distress was marked by a bloated feeling and a dull ache in the upper right quadrant that was relieved by belching. Two days before admission he vomited several times. The referring physician made a tentative diagnosis of gallbladder disease.

X-ray examination revealed nonvisualization of the gallbladder without evidence of stones. The barium meal showed a complete or almost complete pyloric obstruction. The diagnosis rested between duodenal ulcer with stenosis and carcinoma of the pyloric end of the stomach.

The patient was treated with parenteral fluids, blood transfusion and Wangensteen suction over a period of three days and then explored. At operation a mass was found involving the gallbladder, first portion of the duodenum, pylorus and a generous portion of

the omentum. When the adhesions were freed the dome of the gallbladder was seen within a large ulcer defect on the posterior wall of the duodenum. Upon freeing the gallbladder from this edematous mass a perforation of the duodenum was encountered. This large perforation was explored and three pieces of tissue were taken for biopsy. A frozen section revealed an inflammatory tissue. The perforation was closed by a linen purse string suture over which a thick layer of omentum was drawn and sutured. Because of the obstruction a posterior gastro-enterostomy was performed. Gastric resection was not advisable because of the perforation. The recovery was uneventful.

From the surgical point of view this group of ulcers is sufficiently important to warrant the presentation of two more cases.

CASE V—B M a man aged thirty four years presented a typical ulcer history dating back eight years with more severe symptoms during the last five. The patient was a moderate but persistent alcohol drinker and cigarette smoker. During the past two years he had almost continuous distress under modified ulcer management. Two weeks prior to hospital entry the patient had severe night pains over the gallbladder area not relieved by milk and soda.

Under hospital management, consisting of complete bed rest, alkalization and sedation the patient continued to complain of severe night pains at times requiring morphine. Cholecystography revealed a faint visualization of the gallbladder. After three weeks of hospital management the patient had not improved and the pain over the gallbladder area became more acute. He was explored and a duodenal ulcer was found on the anterolateral wall of the duodenum opposite the dome of the gallbladder. The wall of the gallbladder was markedly thickened and edematous yet there was no true extension of the ulcerous process into the gallbladder but a secondary pericholecystitis. Gastric resection was performed with early uneventful recovery.

CASE VI—The last patient, H P a white woman aged forty one years gave a history of severe boring pain in the epigastrium not always relieved by milk and soda. This had been present for a period of one year. Prior to this she complained of vague upper abdominal distress periodically for many years. X ray study of the stomach revealed a large ulcer on the lesser curvature of the stomach.

The patient was placed on strict ulcer management which was a complete failure after four weeks. At operation a large ulcer on the posterior aspect of the lesser curvature of the stomach was

found This ulcer was penetrating into the body of the pancreas A subtotal gastric resection was performed with early uneventful recovery The patient has been symptom free for three years

SUBTOTAL GASTRIC RESECTION—TECHNICAL CONSIDERATIONS

The experiences of clinicians during the past ten years leave no doubt that in the surgical treatment of peptic ulcer the subtotal gastric resection yields the best results Much has been written about the technic of gastric resection

I prepare my patients for surgery by introducing a tube for continuous suction into the stomach the night before operation During this time the patient is allowed to drink clear fluids The suction is checked and the tube removed on call from the operating room In the majority of instances a blood transfusion is started at the beginning of the operation and in all cases normal salt solution is given intravenously during the operation This latter is important because should additional blood be needed the flask containing it is simply attached to the intravenous apparatus already in operation This avoids a disruption of the surgical drapings and any delay in the administration of the blood should the intern have difficulty with the venous puncture

At least three fifths of the stomach is resected The resection includes a variable portion of the duodenum When the ulcer is located in the duodenum an attempt is made to include the ulcer in the resection When this is not possible the ulcer is of course left behind in the duodenum and the distal division is then made as low down in the duodenum and occasionally of necessity in the pylorus as is compatible with a good closure of the stump A posterior Polya type of anastomosis is then made between rubber clamps The entire divided cardiac end of the stomach is utilized in the anastomosis

During the past three years I have given up the use of the various so called sewing machines because they serve to no advantage in the posterior type of anastomosis When the sewing instrument is used a part of the sutured line must be reopened for the anastomosis and therefore there is no decrease in the possibility of contamination

The anterior anastomosis advocated by Lahey and Marshall³ is practiced only in instances of short mesojejunum Even though the experiences of others with the anterior anastomosis have been yielding good results I hesitate placing the anasto

mosis more distally in the jejunum because of the belief that the further distally we proceed from the stomach, the less resistant the intestinal mucosa becomes to the gastric juice. Although there is no proven record of the above assumption it appears to be good physiological sense. Certainly future experiences and good experimentation should settle the issue.

In closing, one should mention the use of the simple *posterior gastro enterostomy*. As an operation for the treatment of peptic ulcers, this procedure has been generally given up because of the high incidence of stomal ulcers. The posterior gastro enterostomy should be reserved for old burned out ulcers with cicatricial stenosis at the duodenum or the pylorus in instances in which gastric resection is either impossible or not advisable.

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TUMORS OF THE STOMACH A CASE STUDY*

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It is our purpose to present in this clinic a selected group of cases§ that illustrate many of the problems that arise in the handling of stomach lesions. These cases represent for the most part the unusual situations which may occur from the standpoint of diagnosis, treatment and prognosis.

EARLY CARCINOMA OF STOMACH DIAGNOSED AS BENIGN ULCER

Our first case demonstrates the difficulty which may occur in correctly diagnosing ulcerating lesions of the stomach.

CASE I—The patient, a twenty-nine year old woman, was admitted to the hospital with a history of epigastric distress for ten years. This distress was burning in character and would come on two to three hours after meals. It was relieved by the taking of food, milk, or sodium bicarbonate. The epigastric distress occurred daily for periods of several months, however, she would then be free from symptoms for several months to as long as a year. She had recently lost 15 pounds in weight.

Gastric analysis showed the presence of free acid. There was no anemia demonstrated by the blood counts. Roentgenologic study of the stomach after a barium meal revealed what was believed to be a large gastric ulcer on the lesser curvature of the stomach (Fig. 10) and a small ulcer in the duodenal bulb. Gastroscopy was attempted but was unsuccessful. A clinical diagnosis of benign gastric ulcer and duodenal ulcer was made.

The patient was treated by medical management which consisted of the usual rest, milk and cream and alkaline powders for a period of seven weeks. During and subsequent to this period of medical management the gastric ulcer decreased considerably in size and the duodenal ulcer healed over, causing some stenosis of the

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§ The cases presented were from the Surgical Sections of the University of Chicago Clinics. In addition to the routine cases the authors have included some in which operation was done by Drs. Phemister, Dragstedt, Brush, and William Adams, to whom their appreciation is expressed.

duodenal lumen. Operation was advised and a subtotal gastrectomy of the posterior Polya type was performed. The original report of the surgical pathological laboratory on the specimen removed at operation was a simple chronic gastric ulcer. The patient made an uneventful recovery and was followed in our out patient department.

About one year after gastrectomy the patient returned with symptoms of constipation and lower abdominal cramps that were relieved by defecation. Rectal examination revealed a stony hard mass in the cul de sac which was adherent to bowel but apparently not originating in bowel wall. This mass bulged into the



Fig 10—X ray after barium meal showing filling defect on lesser curvature which was interpreted as due to benign gastric ulcer but later proved to be carcinoma.

rectum and partially occluded the lumen. A barium enema showed what was thought to be an annular constricting neoplasm of the rectosigmoid colon. Exploratory laparotomy revealed extensive carcinomatosis of the peritoneum and a large tumor mass in the pelvis. This mass did not appear to originate from the bowel or pelvic organs. It undoubtedly represented a secondary carcinoma of the Krukenberg type derived from a malignant tumor of the stomach. Upon reviewing again the microscopic sections of the supposed gastric ulcer removed a year previously several consulting surgical pathologists agreed that the ulcerating lesion of the stomach was an early carcinoma instead of a benign gastric ulcer.

Comment—This case clearly illustrates the difficulty which may occasionally arise in distinguishing not only by clinical methods but also by microscopic examination between an apparent benign ulcer of the stomach and an ulceration due to carcinoma or carcinomatous degeneration of a pre existing benign ulcer

It is probable that the microscopic sections would not have been subsequently diagnosed as carcinoma if there had not been obvious metastases found at the second operation. An experience such as this lends considerable support to the thesis that gastric ulceration is primarily a surgical problem that deserves prompt radical surgery

CLINICAL DIAGNOSIS OF CARCINOMA OF STOMACH NOT DEMONSTRABLE AT OPERATION

The next patient is an excellent example of a clinical diagnosis of carcinoma of the stomach which could not be demonstrated at operation

CASE II—The patient a Polish woman fifty five years of age was admitted to the hospital because of constant pain in the epigastrium during the past two years. She had also noticed weakness and a weight loss of 34 pounds. The taking of food gave some relief from the pain. There was no associated nausea or vomiting.

Physical examination revealed evidence of considerable loss of weight. There was moderate tenderness in the epigastrium and there was some question as to whether a mass could be palpated in this region. The blood counts were normal and the urine negative. Gastric analysis revealed no free acid even after histamine. Other laboratory tests showed negative Wassermann and Kahn reactions, a nonprotein nitrogen of 33 mg., fasting blood sugar of 78 mg., blood amylase 66 per cent (normal) and an icteric index of 1 units.

Roentgenologic study after a barium meal revealed a constant deformity along the greater curvature which was thought to represent a malignant lesion of the stomach (Fig. 11). The esophagus and duodenal bulb were normal. Gastroscopy demonstrated a severe superficial gastritis of the entire stomach and along the posterior wall of the stomach the presence of an infiltrative tumor could not be ruled out.

In view of the history and findings a clinical diagnosis of carcinoma of the stomach was made and operation was requested by the medical service.

At laparotomy the stomach was carefully examined and found to be normal in appearance on the serosal surface and free from any

evidence of tumor in the wall of the stomach Exploratory gastrotomy was done and the lumen of the stomach inspected The severe gastritis seen at gastroscopy was present but no evidence of tumor could be found A small portion of stomach wall along the incision was removed for pathological examination The stomach was closed with two rows of No 0 extra chromic catgut (Type D) The patient made an uneventful convalescence however she continued to complain of severe epigastric pain The microscopic sections of the stomach wall showed only the severe gastritis and no evidence of malignancy



Fig 11—X ray of stomach after barium meal showing deformity along greater curvature which was constant and which was interpreted as due to carcinoma

Comment—In the light of such findings would one be able to exclude a malignant lesion of the stomach in another patient even if a severe gastritis is known to be present, without subjecting the patient to laparotomy? This is doubtful and one must countenance the possibility of errors in clinical diagnosis which may occasionally lead to unnecessary operations if one is to avoid letting some patients go along on a regimen of watchful neglect until their malignant lesions have become more obvious and probably have extended beyond the range of operability

EARLY CARCINOMA OF STOMACH REVEALED BY EXPLORATION AT CHOLECYSTECTOMY IMPORTANCE OF MICROSCOPIC SECTION IN DIAGNOSIS

Tumors of the stomach may be incidentally found during the course of operations on other abdominal organs if careful exploration is routinely carried out at laparotomy. Our next patient is an excellent example of such a situation.

CASE III—The patient a woman thirty eight years of age was admitted with a history of recurring attacks of right upper quadrant pain which radiated to the back and to both shoulder regions. These attacks which had been occurring for a year would last three or four days and be followed by residual right upper quadrant tenderness for a week. There was some loss of appetite and a weight loss of 25 pounds.

The physical examination was essentially negative. The red blood count was 3 450 000 and the hemoglobin was 68 per cent. Gastric analysis showed free acid. Three fluoroscopies after a barium meal failed to reveal any evidence of ulcer or neoplasm of the stomach. The cholecystogram revealed nonvisualization of the gallbladder. Gastroscopy did not demonstrate any evidence of ulcer or tumor. A diagnosis of chronic cholecystitis and cholelithiasis was made and cholecystectomy was advised.

The patient was operated upon with the intent of doing a cholecystectomy but during the course of routine exploration of the upper abdomen a small infiltrative lesion of the posterior wall of the stomach was found. This was interpreted as an early carcinoma of the stomach and a subtotal gastrectomy was performed. The gallbladder was not removed at this time since it did not appear appropriate to add any further hazard to the handling of the major pathologic condition by attempting to deal with what had become a relatively minor lesion. The microscopic sections of the gastric lesion confirmed the diagnosis of carcinoma.

The patient made a satisfactory recovery from the operation but continued to be troubled with gallbladder attacks. She was operated upon ten months after the gastrectomy with the intent of removing the gallbladder. On exploring the upper abdomen numerous firm white nodules studded the peritoneal surfaces in the region of the previous operation as well as over the dome of the liver. These were interpreted as widespread carcinomatous implants in the peritoneum and so her gallbladder was not removed. One of the nodules was removed for pathological examination. The microscopic section showed a granuloma which had been stimulated by the talcum powder (Fig. 12) from the surgeon's gloves which was introduced into the peritoneal cavity at the time of the gastrectomy. There was no evidence of carcinoma. In view of continued symp

toms from gallstones the patient's gallbladder was subsequently removed and she has remained in good health for the two and a half years since the gastrectomy.

Comment—This case is of interest from two points of view. In the first place it emphasizes the importance of making a routine exploration of abdominal organs when the abdomen is opened even if a careful clinical and roentgenologic study has presumably excluded the presence of disease in certain organs.

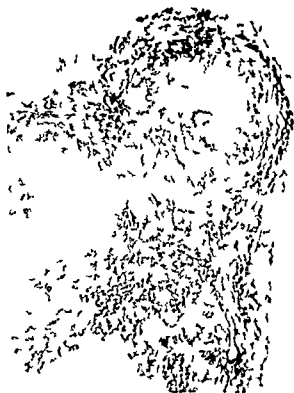


Fig. 12—Photomicrograph of a nodule which was removed from the peritoneum and which had the gross appearance of a secondary carcinomatous implant. This lesion represents a granuloma which has been stimulated by the talcum powder from the surgeon's gloves which was introduced at a previous operation.

In this instance if the surgeon had failed to find this early carcinoma of the stomach which had not been suspected after three careful roentgenologic examinations and one gastroscopy it is doubtful whether attention would have been drawn to this lesion very soon after a cholecystectomy. One would probably have attributed any symptoms from the carcinoma to a post-cholecystectomy syndrome and by the time the carcinoma of the stomach was obvious it would probably have been inoperable.

The second point of interest is the talcum powder granulomas which had a gross appearance that was mistaken for multiple secondary carcinomatous implants of the peritoneum until the microscopic section clarified the diagnosis. This emphasizes the necessity of microscopic examination before making decisions regarding operability or inoperability in any particular case. If this patient had had a cholecystectomy originally and the carcinoma of the stomach was found at a subsequent operation it is very probable that without such an examination the patient would have been considered inoperable because of the presence of the multiple powder granulomas which looked like peritoneal implants of carcinoma. The wider use of the rapid frozen section technic to clarify the nature of the lesion while the patient is on the operating table should be encouraged although this technic does have certain limitations in some cases from the standpoint of accuracy of diagnosis which may require substantiation by the usual routine technic for preparation of microscopic sections.

It is difficult to estimate how often powder on the gloves of the operating team may produce these foreign body granulomas in the peritoneum. This case emphasizes the need for the surgeon constantly to remind his operating team to wash off the powder—a supposedly routine procedure which is often ignored. Although these powder granulomas may not produce serious complications it is quite obvious that reasonable care should be taken to avoid them.

MALIGNANT TUMOR OF THE STOMACH IN AN AGED PERSON

One may be confronted with the problem of what to do about a patient of seventy years of age or more who is found to have a tumor of the stomach. Should one always explore and then attempt resection or palliation or should one limit himself to operation in a few cases which appear to offer the most favorable prognosis? *Let us consider the following case for light on this point.*

CASE IV—A woman seventy years of age had been having epigastric distress for about a year and a moderate loss in weight. She had a mass in the upper abdomen the size of a grapefruit. Roentgenologic study after a barium meal revealed an extensive lesion of the distal portion of the stomach. The clinical diagnosis was carcinoma of the stomach which was probably inoperable.

The patient was operated upon under local anesthesia and it was

found to be technically feasible to do a gastrectomy of the posterior Polya type even though the tumor was quite large and partially adherent to surrounding structures. This tumor proved to be a papillary carcinoma of the stomach. The patient had a moderately stormy convalescence, but made a satisfactory recovery. She was followed over a period of eight years during which period she gave no evidence of recurrence, when death occurred from what seemed to be a cerebral accident.

Comment—The excellent result from gastrectomy in this seventy year-old patient who was thought to have an inoperable carcinoma of the stomach favors the view that elderly patients should be given the benefit of exploratory laparotomy even if the clinical evaluation of the situation prior to operation appears to offer a poor prognosis for gastric resection.

LEIOMYOSARCOMAS OF STOMACH IN A YOUNG MAN WITH PRESUMED PRIMARY ANEMIA

Our next patient is a young man who had been treated for anemia for two years before coming to our clinic. He is a striking example of the fallacy of treating a presumed primary anemia without searching for a source of bleeding in the alimentary tract.

CASE V—The patient, a man aged twenty five years gave a history of intermittent attacks of crampy epigastric pain associated with weakness, dizziness, tachycardia, dyspnea, and occasional fainting spells. When these attacks occurred, which was about every three months, he noticed a lemon yellow tinge to his skin. There was no nausea or vomiting with these attacks. Lestron and tetracycline and dilute hydrochloric acid relieved them. During a recent attack his red blood cell count was reported to have been as low as 2 800 000.

On admission, except for pallor and some emaciation, the patient's general physical examination was negative. His blood studies showed a red blood count of 4 000 000, a hemoglobin of 11.6 gm., white blood cell count of 9000 and a normal differential count. Roentgenologic studies after a barium meal revealed what was believed to be a spectacular case of gastric polyposis (Fig. 13). Gastroscopy demonstrated the presence of multiple polyps which were thought to be benign in nature, although the possibility of malignant degeneration could not be definitely excluded. Gastric analysis showed the presence of free acid.

Exploratory laparotomy revealed that there were at least five pedunculated tumors of the stomach wall. These tumors extended

not only into the lumen of the stomach but also under the gastric serosa. The stomach was opened and the tumors with one exception were found to be covered with intact mucosa. In this tumor a deep ulceration in the mucosa was found which apparently was the source of the bleeding.

In view of the extensive involvement of the stomach and the fact that the stomach appeared to be fixed posteriorly to the retroperitoneal tissues it was decided to remove only one of the lesions for biopsy at this time. This lesion was found to be a leiomyosarcoma. A course of x ray therapy was given in the hope of increasing the operability of the gastric lesions.



Fig 13—X ray of stomach after barium meal which shows multiple polyps later found to be leiomyosarcomas

At reoperation two months later a total gastrectomy with esophagojejunostomy was performed (see Fig 14 showing gross specimen and Fig 15 showing photomicrograph). The patient made a satisfactory recovery from the operation and was able to return to work. He has had to take liver extract at intervals of three weeks. He eats three meals a day with frequent snacks between meals. One point of interest is that he does not have any hunger sensation. He feels rather full after eating a meal but does not have discomfort unless he takes more than two thirds of the amount of food he was previously accustomed to eating. He has gained 30 pounds in weight and maintains himself in relatively good



Fig 14—Photograph of stomach after total gastrectomy showing multiple polypoid tumors which were leiomyosarcomas

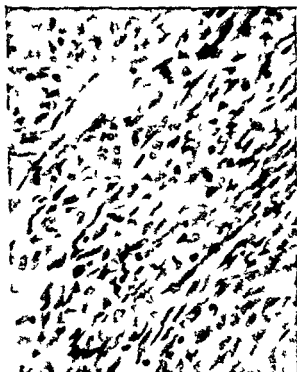


Fig 15—Photomicrograph of leiomyosarcoma of stomach

condition There is no evidence of recurrence two and one half years after operation

Comment—This case illustrates the importance of searching for a cause of what may be considered to be a primary anemia, as well as the importance of countenancing extensive surgery when dealing with a malignant lesion in a young individual. Although the patient was cured of his secondary anemia by the removal of the source of the bleeding which was the ulcerated leiomyosarcoma we have since had to treat him as though his was an ordinary case of primary anemia because of the complete removal of his stomach.

FILLING DEFECT SUGGESTING A PEDUNCULATED TUMOR OF THE
STOMACH BUT DUE TO TRICHOBEZOAR

In routine gastric fluoroscopy one may occasionally encounter a filling defect which has many of the appearances of a large pedunculated tumor of the stomach but is not due to a lesion of the stomach per se. This is illustrated in the following case report.

CASE VI—A sixteen year old girl came to our clinic with a history of nausea and vague abdominal pain for the past year. The pain would usually come on shortly after the ingestion of a large meal and would last from fifteen minutes to a half hour. Three months before her admission her mother noted a lump in the epigastrium. Two months before her admission an exploratory laparotomy was performed at another hospital and a large hair ball weighing 4 pounds was removed from the stomach. Following operation she got along very well for one month when she again noted a mass in the epigastrium. This lump increased in size and she again developed nausea and vague abdominal pains. The mother states that the girl is nervous and pulls out hair from her head particularly at night and puts it in her mouth. In addition, she apparently removed hair from her pet dog and ate this also.

Examination of the patient's head revealed a diminution of hair but no evidence of recent massive epilation. A palpable ballotable mass was present in the epigastrium. Roentgenologic study after a barium meal showed a large filling defect of the stomach which had the appearance of a large papilloma or a foreign body (Fig 16). Gastroscopy revealed a large hairy mass which almost completely filled the lumen of the stomach. The diagnosis of tricho bezoar was made and operation advised. A gastrotomy was performed and a large hair ball measuring 14 by 7 cm. was removed from the gastric lumen (Fig 17). The incision in the stomach was closed with two rows of chromic catgut (No 0 size Type D extra chromic). The patient made an uneventful recovery.



Fig 16—X ray of stomach after barium meal showing large filling defect which was compatible with a pedunculated tumor of the stomach but which was due to large hair ball



Fig 17—Photograph of foreign body removed from stomach which was composed of dense mass of hair 14 by 7 cm which the patient had removed from herself and her pet dog

MULTIPLE BENIGN POLYPS OF THE STOMACH TREATED BY SLEEVE RESECTION

The following report illustrates a method which may be applicable in some instances of multiple benign polyps of the stomach

CASE VII—A woman aged thirty eight years was admitted with a history of recurrent upper abdominal pain over a period of twelve years. This pain occurred only after eating a fairly large meal and was associated with nausea but no vomiting



Fig. 18. X ray of stomach after barium meal which shows multiple filling defects due to benign polyps of stomach

Physical examination demonstrated some tenderness in the upper abdomen. The red blood cell count was 3 800 000 and the hemoglobin 11 gm. Gastric analysis showed no free acid even after histamine. All the specimens aspirated from the stomach contained blood. Roentgenologic study after a barium meal showed multiple filling defects which were believed to be gastric polyps (Fig. 18). At gastroscopy the multiple polyps of the stomach could be seen extending from just above the angulus almost to the cardia.

At operation all of the polyps were found to be present in the midportion of the stomach. A sleeve resection of the involved portion of the stomach was performed with an end to end anasto-

mosis of the cardiac portion of the stomach to the pyloric portion (see Fig 19 showing specimen) Pathological examination showed the lesions to be typical benign polyps without evidence of malignancy The patient made an uneventful recovery from the operation



Fig 19—Photograph of portion of stomach removed by sleeve resection which demonstrates multiple benign gastric polyps

Comment—In cases of multiple benign polyps it is usually necessary to resort to a subtotal or possibly total gastrectomy to remove all the lesions however in this instance a satisfactory result was apparently obtained with a less extensive procedure

EXTENSIVE CARCINOMA OF STOMACH NOT REVEALED BY X RAY VALUE OF MASSIVE TRANSFUSIONS IN EXTENSIVE SURGERY

In some instances careful roentgenologic study of the stomach may not reveal the presence of an extensive carcinomatous involvement as in our next case

CASE VIII—A man forty three years of age had been suffering from epigastric distress for a period of six months. This pain was mild at first but gradually increased in severity. It was much worse just before meals and was improved by eating or taking of milk. He was never awakened at night by pain but it was present when awaking in the morning. He had considerable vomiting at the beginning of his symptoms but this was relieved when a doctor



Fig. 20.—Photograph of stomach removed by total gastrectomy which shows the typical "leather bottle stomach" due to diffuse scirrhous carcinoma.

gave him belladonna. He had frequent tarry stools for the duration of the symptoms and had lost about 40 pounds in weight.

Physical examination was essentially negative except for tenderness in the epigastrium. Laboratory studies revealed his blood to be within normal limits. Stools on a meat free diet were positive for blood. Gastric analysis showed free acid. The Wassermann test was negative. After careful repeated roentgenologic studies with a barium meal it was thought that there was an hour glass scarring

from a benign ulcer in the antrum Syphilis of the stomach and a soft infiltrative neoplasm of the gastric antrum were also considered as possibilities GastroscoPy was unsuccessful

An exploratory operation was done under continuous spinal anesthesia (650 mg of novocain over a period of five hours) and an infiltrating scirrhouS carcinoma was found which involved the entire stomach producing the characteristic leather bottle type of lesion A total gastrectomy was performed and an end to side anastomosis was made between the lower end of the esophagus and a proximal loop of jejunum It was also necessary to remove the spleen to expedite the complete removal of the stomach (Fig 20) The patient stood the operation well owing in no small measure to the administration of 1900 cc of whole blood during the operation His postoperative convalescence was uneventful The pathological report was diffuse scirrhouS carcinoma of the stomach

Comment—Aside from the extensive carcinoma of the stomach that was not revealed by x ray, this case further illustrates how well patients may tolerate extensive surgery if given adequate blood transfusions during operation It is of interest that there was no evidence of reaction to the 75 gm of sodium citrate that was required as an anticoagulant in the 1900 cc of blood given during the course of the operation It might be mentioned at this point that we have used massive transfusions in many other cases without evidence of untoward reactions to sodium citrate

SUCCESSFUL REMOVAL OF CARCINOMA OF CARDIAC END OF STOMACH BY THORACOLAPAROTOMY IN AN AGED PERSON

The next case demonstrates the successful removal in an aged patient of a carcinoma of the cardiac end of the stomach with esophageal extension which would have been considered technically inoperable a few years ago

CASE IX—The patient a man aged eighty two years came to our clinic with a history of dysphagia for three weeks He noticed that meat would stick in the esophagus at a level of about the mid portion of the sternum however he was able to force the food down by taking a small sip of water He was able to get along quite well by limiting his diet to soft foods and liquids

Physical examination which was essentially negative revealed an elderly man who appeared to be in excellent health and well preserved for his years Blood counts were normal Roentgenologic study after a barium meal revealed a filling defect in the lower end of the esophagus which extended into the fundus of the stom

ach There were moderate obstruction to the flow of barium On the basis of these findings a diagnosis was made of carcinoma of the cardiac portion of the stomach which had extended into the lower end of the esophagus

Technic of Operation—Operation was advised in spite of the patient's age because of the excellent state of his health Under ethylene anesthesia supplemented by ether the lesion was exposed by a transthoracic approach A long incision was made over the course of the left eighth rib which was then resected subperiosteally The pleural cavity was opened through the periosteal bed and the mediastinal structures were explored The diaphragm was opened and the peritoneal cavity exposed A tumor of moderate size was found to involve the cardiac portion of the stomach and abdominal portion of the esophagus A few hard lymph nodes were found along the lesser curvature but no evidence of metastases was found in the liver or in the mediastinum The spleen was then removed to expedite the resection of the tumor The gastrohepatic and gastrosplenic ligaments were divided from the proximal half of the stomach The lower third of the esophagus was mobilized from the posterior mediastinum The proximal half of the stomach and the lower fourth of the esophagus were resected The open end of the stomach was closed and an end to side anastomosis made between the lower end of the esophagus and the anterior wall of the stomach Omentum was wrapped around the anastomotic suture line and the diaphragm was closed about the stomach A de Pezzer catheter was brought out through a separate stab incision in the left tenth interspace in the posterior axillary line and the chest incision was then closed in layers with chromic catgut The lungs were partially re-expanded under positive pressure from the anesthesia apparatus and further expansion was maintained by constant suction of the de Pezzer catheter which was connected to a Wangensteen type of siphon apparatus The patient was given a transfusion of 1800 cc of blood during the course of the operation

Subsequent Course—The patient's postoperative convalescence was relatively uneventful A point in the postoperative management which deserves mention is the desirability of replacing protein loss such as may occur from the constant withdrawal of pleural exudate by the suction apparatus Under such circumstances the pleural exudate may have a protein content

of 4.5 gm per cent, and the withdrawal of considerable amounts of this exudate may contribute to an appreciable and detrimental degree of hypoproteinemia. For this patient a plasma transfusion of 500 cc was given two days after operation to make up for the loss of protein in the pleural exudate. The pathological report was carcinoma. The patient is in good health now six months after operation.

Comment—This case illustrates the advances which have been made in recent years in surgical technic which has permitted the successful removal of malignant tumors of the cardiac end of the stomach and lower end of the esophagus by a trans thoracic thoricothoracotomy such as was described. Such extensive surgery cannot be successfully undertaken, however, without providing massive blood transfusions during the course of operation.

PERFORATION OF GASTRIC WALL DURING ATTEMPTED GASTROSCOPY

In giving a patient the benefit of a thorough diagnostic study for an abdominal complaint, one must not lose sight of the fact that gastroscopy may be an appreciably hazardous procedure, as is demonstrated by our last case.

CASE V.—A woman sixty-six years of age came under our observation for epigastric pain associated with loss of appetite for a period of nine months. Her past history revealed that she had suffered epigastric distress associated with vomiting many years ago. This lasted for several years and then she was free from distress until her recent difficulty during the past nine months. This epigastric pain came on one to two hours after meals and awakened her in the middle of the night. The pain was relieved by milk and by sodium bicarbonate.

Physical examination was essentially negative. Gastric analysis showed free acid. There was no anemia revealed in the blood counts. Roentgenologic examination after a barium meal demonstrated an ulcerating lesion of the lesser curvature of the stomach which was believed to be a carcinoma but a benign ulcer of the stomach could not be entirely ruled out.

In an endeavor to clarify the diagnosis which from the history favored benignancy rather than malignancy a gastroscopy was recommended. This was performed with some difficulty and it became immediately apparent that the tip of the gastroscope had perforated the wall of the stomach before any observations could be made of the lumen. Fluoroscopy revealed air under the diaphragm. Laparotomy was performed immediately and a perforation

on the posterior wall of the stomach was closed with two rows of chromic catgut. There was a fairly extensive involvement of the stomach by carcinoma although the perforation was through an uninvolved portion of the stomach. The patient made an uneventful recovery and subsequently had a successful subtotal gastric resection.

Comment—There have been three other diagnostic accidents during the development of gastroscopy at the University of Chicago Clinics. Two of these were perforations of the stomach which were immediately closed without mishap. However a perforation of the esophagus by the gastroscope resulted in a fatal mediastinitis. Gastroscopy represents a definite contribution to the diagnosis and scientific study of diseases of the stomach and should undoubtedly be utilized wherever a competent endoscopist is available. Nevertheless gastroscopy cannot be considered as an entirely innocuous diagnostic procedure. And furthermore the usefulness of gastroscopy should not be overemphasized because it did not contribute appreciably to the accuracy of the preoperative clinical diagnosis in any of the cases presented in this clinic on tumors of the stomach.

PENETRATING WOUNDS OF THE ABDOMEN

RAYMOND W McNEALY MD FACS

PENETRATING wounds of the abdomen include a wide variety of visceral injuries. I have had patients on my service with lacerations of the abdomen which extended from side to side and permitted many loops of the intestine to prolapse. One patient actually walked into the Receiving Office carrying his small intestines wrapped in a towel. This patient was operated on and made a recovery which was as uneventful as that following a well designed surgical laparotomy.

In military practice the character of the injuries will vary with the changing weapons used to destroy people. The present total war has erased almost completely the difference between military and civil practice. Innumerable women and children have suffered from bomb casing fragment injuries. Incendiary bullets now being used not only inflict the usual penetrating wounds but frequently cause considerable tissue necrosis as well.

In penetrating wounds of the abdomen one is usually relieved of the responsibility of deciding whether or not surgical intervention is necessary. Operation is imperative in practically every penetrating wound of the abdomen. If the patient is seen early and facilities for anesthesia and surgery are to be had, no preventable delay in exploring the abdomen should be allowed.

If a patient is not seen during the first twenty-four hours following a penetrating injury and he seems to be making satisfactory progress, one might reasonably consider delaying exploration. In such cases duodenal suction should be used and no fluids permitted by mouth. Patients who have wounds inflicted by stabbing or bayoneting are often in better condition than those in whom the wounds have been caused by bullets or shell fragments. A partial explanation for the more benign character of the stab wound is that bullet wounds are likely to traverse greater distances and cause greater destruction by their explosive effect. This is especially true in viscera containing fluid. There is also likely to be much dispersion of the contaminated

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contents of the intestinal tract. In stab wounds the clean cut character of the injuries may leave the wound edges in approximation and the opening itself may be completely sealed by prolapsed mucosa.

When the patient is seen early, no surgeon should delay operation in the hope that the wound will be the one which will not lead to peritonitis or hemorrhage.

In the bombardments in Barcelona during the recent Spanish Civil War abdominal wounds accounted for approximately 9 per cent of the casualties. Penetrating wounds of the hollow viscera in our experience at Cool County Hospital carry a mortality rate of around 65 per cent while injuries to the solid viscera alone have a mortality rate of around 30 per cent. If the injury to the solid viscera is accompanied by penetration of the chest the mortality rate is increased. Shock is usually marked in injuries to the hollow viscera and the symptoms of internal hemorrhage are likely to dominate the picture of these injuries.

It is difficult to generalize in discussing the symptoms of penetrating injuries of the abdomen because of their bizarre character. It is equally difficult to offer a general plan of management for these cases. No amount of theoretical consideration will take the place of experience in handling emergencies of this type.

The literature of the present time is replete with reviews covering the management of penetrating wounds of the abdomen. One might presume from the tenor of some of these articles that there is some difference between the surgery of military and the surgery of civil practice. Fundamental principles of sound surgery must prevail in either practice if the mortality rate is to be kept low. No amount of sulfa drugs will prevent the leakage of contents from insecurely sutured wounds of the intestine. The sprinkling of liberal amounts of these bacteriostatic agents along suture lines and in the parietal wounds may encourage a feeling of security which is not warranted unless meticulous care in every other technical detail is exercised.

GENERAL MANAGEMENT

Preoperative Management

Many of these patients are in shock and not a few suffer from loss of blood. One must decide which is predominant and institute the recognized treatment for each. The availability of whole blood, serum, plasma and glucose solutions has greatly simplified

this problem. It should be remembered that no delay should occur in the earliest possible introduction of shock combating solutions. It is also necessary in many instances to continue them during the surgical procedure and afterward.

The emergency presented by injuries to the hollow or solid viscera is never so desperate that time cannot be taken for carrying out certain routine examinations and preparations. In the case of patients with systolic blood pressures less than 100 it is far more important to combat the shock or hemorrhage than it is to rush them unprepared to immediate surgery. Repeated observations convince one that if patients cannot be brought out of their shock *before* operation they will not come out of it during or after surgery. Transfusions of whole blood in amounts approximating the loss should be given to patients who have had massive hemorrhages. It is all too common for these patients to be hurried to operation after a single transfusion of 500 cc. or less of blood. The mortality following this injudicious practice has led us to speak of these insufficient transfusions as *ritualistic*. I agree with the statement of Meyer and Shapiro that if after the primary treatment of shock with morphine, rest and warmth the blood pressure does not rise above 80, shock there after for all practical surgical purposes should be assumed to mean hemorrhage.

Preparation of the Operative Field

One might feel inclined to apologize for injecting this subject at this time were it not for the fact that one so frequently sees seriously embarrassing predicaments arise from the failure to prepare widely beyond the evident site of injury. We have made it a rule to have all patients with abdominal injuries prepared from the nipples to half way down the thighs and laterally well into the flanks.

So much has been written about the liberal use of soap and water in the preoperative preparation of patients that a word of caution should be spoken. There can be no doubt that soap and water will help greatly in cleaning up contaminated areas. The washing out of jagged irregular superficial wounds followed by thorough debridement may lessen considerably the tendency of these to become infected. In the simpler penetrating wounds it may not be advisable to rub the abdomen as freely as we are accustomed to do in the usual preparation for laparotomy. In most of these patients it will suffice to shave the area and paint

with one of the usual antiseptic solutions. There is little doubt that more vigorous pressure on the abdomen may stimulate peristalsis or actually compress the gas filled intestines and cause some added escape of intestinal contents.

Anesthesia

The anesthetic of choice should be the one with which the operator and the anesthetist are most familiar. As thorough extensive exploration will be the rule, the choice of anesthetic should anticipate the need for a quiet intestinal field and thorough parietal relaxation. I doubt the wisdom of using local anesthesia in exploratory operations of the type under consideration. Spinal anesthesia may have to be used in circumstances in which inhalation anesthesia for various reasons cannot be had or properly trained personnel is not at hand. The use of preliminary doses of morphine or morphine and atropine is still routine with most surgeons.

Instruments and Supplies

The lack of foresight on the part of surgeons, residents and surgical nurses in anticipating the possible needs in penetrating wounds of the abdomen has led to many embarrassing unnecessary delays. Therefore it does not seem amiss to mention a few of the instruments and supplies which are sometimes omitted from the set up for such cases.

- 1 Rubber covered clamps should be in every set, as well as a wide variety of catgut and silk intestinal sutures.
- 2 Mechanical retractors like those used in pelvic surgery may provide excellent exposure and free the hands of the assistants.
- 3 Suction apparatus should be set up at the beginning of the operation.
- 4 Varying sized catheters and rubber tubes should also be a part of the equipment.
- 5 Gauze of the type of uterine packing should be readily available and soft rubber tissue drains should be sterilized ready for use.
- 6 Shaker containers with the familiar sulfa drugs should be at hand.
- 7 It is also important to remember that a stomach tube can be used to remove food from the stomach of the patient who has eaten shortly before surgery.

- 8 A rectal tube may be inserted at the beginning of the operation to deflate the large bowel before and during the course of the operation
- 9 Warm normal saline solution should be available for sponging and washing out gross contaminations. It is doubtful if anyone is inclined to try to flush out the peritoneal cavity with large amounts of solution

Incision

In large wounds or lacerations of the abdomen it may be advisable to open through the previous injury. In such cases a thorough debridement and cleansing should precede the more extensive exploration of the abdominal contents. In the smaller gunshot or stab penetrations it may be more advantageous to avoid the original wound and use one of the accepted incisions for abdominal exploration. It is not always the occasional operator who unwittingly handicaps himself by ill chosen insufficiently wide incisions. From the experience of many of us it seems that the inhibiting influence of prospective hernias too frequently outweighs the necessity for thorough exploration and meticulous repair of every injury.

MANAGEMENT OF INJURIES OF THE INDIVIDUAL VISCERA

Once the peritoneal cavity is opened, it is often a wise provision to mark in some fashion the first loop of intestine that presents itself. This can be done by inserting superficially in the gut wall or the mesentery a black silk stitch leaving its end rather long. This will serve as a marker and indicate the intestines which have already been explored either above or below the point of the marker. If one does not immediately mark the site of initial exploration reduplication almost always ensues. The urge to work in haste has led many operators to begin an exploration before the parietes are relaxed and the breathing of the patient smooth. This results in the use of unnecessary force and frequently contributes to extensive spillage of intestinal contents which might well have been avoided by a little more cautious and delayed effort.

An important lesson can be learned from the autopsy reports on those patients who have died following perforating wounds of the abdomen. It was found in the Cool County Hospital series that 50 per cent of those who succumbed following operation had perforations which had escaped notice at the time of operation. This serious defection should not encourage surgeons

to prolong unduly exploration for fear of overlooking hidden wounds. Usually one can visualize the path of a bullet from entrance to exit and reconstruct its pathway sufficiently accurately to leave little doubt of the location of all of the visceral injuries.

Injuries to the Small Intestine

Sharply incised wounds offer little difficulty of repair. It is the author's personal opinion that no continuous suture should be used in closing defects in the intestinal tract. When crushing or explosive effects have caused considerable trauma to the wall one should carefully consider the wisdom of depending on the suture of these defects without first cutting away traumatized edges. One should also carefully weigh the choice between cut

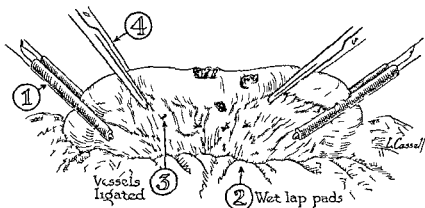


Fig. 21—Technique for small bowel resection

ing away the edges and making a complete transverse resection of the injured area, to be followed by end to end or lateral anastomosis. A fairly good rule is to regard resection as the procedure of choice in the following instances: (1) when the injury is irregular and involves one third or more of the bowel circumference; (2) when the injury involves the mesenteric side of the bowel and infringes on the mesentery; (3) when two or more wounds of the intestine occur within a longitudinal distance of 3 inches (Fig. 21) and (4) where several extensive wounds occur in a comparatively limited section of intestine.

The selection of end to end or lateral anastomosis in repair of the small intestine seems to vary with the operator. I favor the end to end type of anastomosis with interrupted sutures throughout. Interrupted catgut sutures are used for the first layer and

the serosal layer is approximated with very fine interrupted silk sutures. The manner of staggering the mesenteric border of the small intestine is shown in Figure 22.

There rarely occurs any necessity for establishing a temporary enterostomy in injuries of the small intestine. Patients whose conditions are so precarious that this method suggests itself usually succumb from the disturbed water and chemical balance resulting from the enterostomy.

Some of the most difficult decisions to make are those in which extensive tears occur in the mesentery of the small intestine. If

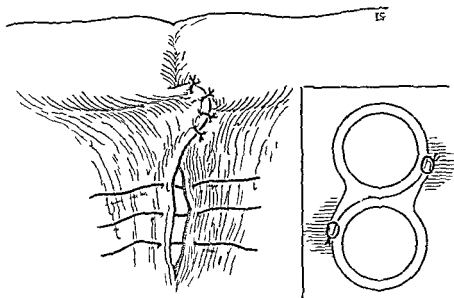


Fig. 22—Manner of staggering mesentery of small intestine

the tear is not within 1 inch of the bowel, there is usually enough collateral circulation to carry rather extensive lengths of the bowel, and a conservative practice of repairing the rent without bowel resection will probably give the best results.

Injuries to the Liver

If the disruption of the organ has been extensive, the bleeding will offer a major problem. In simple bullet or stab wounds, no particular effort should be made to suture or plug the openings unless active bleeding is still in progress. In every liver injury, insecurely attached fragments should be removed and adequate drainage of blood and bile to the outside established by Penrose or soft tubes. Bile is a serious offender and gives rise to a very irritative type of peritonitis. In extensive injuries of the liver, it may be necessary to use a type of mattress suture in which free

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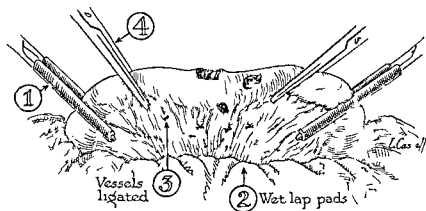


Fig. 21—Technic of sequence for small bowel resection

ting away the edges and making a complete transverse resection of the injured area to be followed by end to end or lateral anastomosis. A fairly good rule is to regard resection as the procedure of choice in the following instances: (1) when the injury is irregular and involves one third or more of the bowel circumference; (2) when the injury involves the mesenteric side of the bowel and infringes on the mesentery; (3) when two or more wounds of the intestine occur within a longitudinal distance of 3 inches (Fig. 21) and (4) where several extensive wounds occur in a comparatively limited section of intestine.

The selection of end to end or lateral anastomosis in repair of the small intestine seems to vary with the operator. I favor the end to end type of anastomosis with interrupted sutures throughout. Interrupted catgut sutures are used for the first layer and

Injuries to the Kidney

Injuries to the kidney which involve the pelvis practically always necessitate removal of the kidney. Penetrating wounds which do not involve the pelvis may be treated conservatively especially if drainage to the surface is provided immediately after injury. It is uncommon to have to suture the kidney substance although this has been done successfully on my service. In one patient a free muscle transplant was used to cover the raw surface left by removal of the upper pole of the kidney. Injuries to the ureter may be repaired if they are small or the two ends may be ligated. If the condition of the patient warrants the kidney may be removed at once. If the condition is more serious the kidney may be left in place and resected at a later date.

Injuries to the Bladder

Injuries to the bladder should be repaired with catgut and an indwelling catheter kept in place for five to seven days. When the bladder is considerably torn it is probably safer to do a suprapubic cystostomy. The author has had five patients in whom traumatic perforation of the bladder has occurred and thus has communicated with the rectum. In these cases gas escapes through the urethra and urine escapes through the rectum. In all five patients an indwelling catheter was placed in the bladder and a rectal tube was kept in the rectum. It is interesting to record that spontaneous healing occurred in each patient and no permanent communication followed. In no case was it necessary to employ surgery to facilitate the closure of the fistulous tract.

Injuries to the Pancreas

Injuries to the pancreas are nearly always associated with perforations in the surrounding viscera. Conservative management with control of hemorrhage and provision for drainage is the rule of treatment.

Injuries to the Large Bowel

Perforations of the large intestine are among the most disastrous perforations that one has to treat. In anteroposterior perforations there may be little difficulty in closing the wounds on the anterior aspect of the bowel but wounds in the posterior

part are unusually difficult to manage. The posterior wounds are often ragged and their edges ill defined. There is in addition likely to be considerable contamination of the retroperitoneal space. Infections developing here jeopardize the security of the suture line and often give rise to extensive retroperitoneal cellulitis. The latter is a serious complication and very difficult to combat.

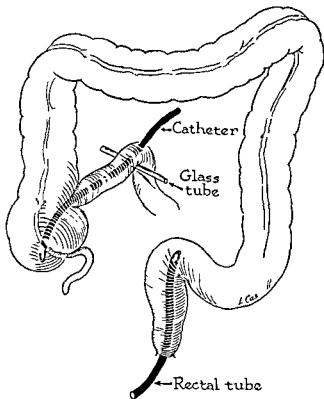


Fig 24—Deflation of large bowel by catheters and ileostomy

No amount of detailed description can cover the perplexing situations which may arise in wounds of the large bowel but a few principles should be kept constantly in mind. It is never safe to close a perforation of the large bowel on the posterior aspect without providing for diversion of the gas and fecal stream through an ileostomy or a ventilation cecostomy. It is probably safer to use an ileostomy which will completely divert the fecal stream but it is also imperative to insert a catheter through the ileocecal valve and to keep a rectal tube in place in order to prevent gas pressure in the large bowel (Fig 24). Regardless of

how securely one may be able to close the perforations in the large bowel, it is necessary to keep in mind that if the retroperitoneal space is contaminated adequate provision must be made for drainage before extensive cellulitis has had a chance

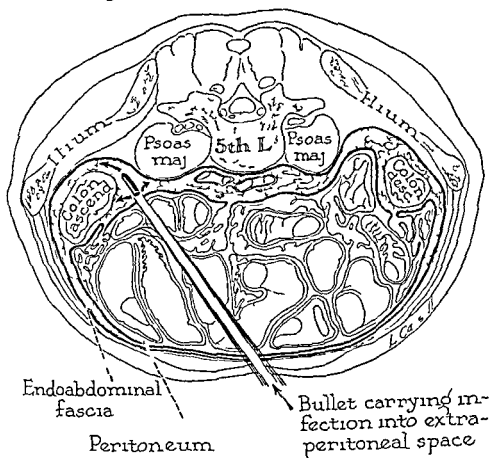


Fig 25—Extraperitoneal space infection may occur when either large or small bowel is penetrated

to develop (Fig 25). In other words when the wound of exit is in the flank or on the back, this wound should be enlarged and kept open by rubber tissue drains until the danger of spreading cellulitis is past. It is not necessary to carry these drains into the peritoneal cavity.

GENERAL CONSIDERATIONS

A *cleansing toilet* of the intestines and limited areas of the peritoneal cavity using normal saline solution and gauze is almost universally accepted practice. There are very few advocates of any extensive flushing of the free peritoneal cavity. It is far more important to cleanse thoroughly the area injured and close the wound meticulously than it is to depend on any form of drainage of the free peritoneal cavity.

No hard and fast rules for *drainage* can be set forth but it is the consensus that with the few exceptions noted before in the paper drainage of the free peritoneal cavity has little to recommend it. This principle is in direct contradistinction to the benefits derived from drainage of the retroperitoneal space. It is apparent from observation of the cases in Cook County Hospital that the failure to provide extraperitoneal drainage of the soft tissues and particularly the retroperitoneal space has contributed generously to the morbidity and mortality in our series.

In the use of *sulfa drugs* it is too early to offer any definite rules but in no instance should large quantities of these drugs be dumped into areas where they may become walled off or pocketed and act as foreign bodies.

APPLICATION OF THESE PRINCIPLES IN WAR

To show the application of the principles outlined in this clinic to the handling of penetrating wounds on the battlefield I wrote to one of my former associates Major Manuel E. Lichtenstein, Chief of the Surgical Division of the Michael Reese Hospital Unit stationed somewhere in Italy and asked him to send a brief outline of their management of these cases both in the African campaign and in the campaign in Sicily. His reply dated October 29, 1943 is as follows:

The general principles of abdominal especially intestinal surgery have not changed at all since I was your intern in 1914-1915. The use of sulfonamides is only an addition to hold in check the peritonitis that frequently develops to overwhelm the acutely injured patient. I will be more specific to outline our practice right here in the field.

First of all in the recognition of abdominal injuries critical diagnosis is important. Do you recall the diagram on the black board showing that the abdomen has a top, bottom, front, back and sides? Well, we try to get the officers to take a "good look." Wounds of the chest, thigh, buttocks, back and perineum frequently involve the abdomen. Land mines, shrapnel, flak, bullets, bomb and shell fragments may enter the abdomen from any angle hence a thorough examination is essential. The rectal examination, urine examination and fluoroscopy if necessary are part of the complete examination. By the time the patient has reached our hospital he has already been given 5 gm. of sulfanilamide by mouth in most cases. If not 5 gm. of sulfadiazine is given intravenously. When a patient is brought in directly from the field the treatment of shock is commenced and along with other

intravenous infusions goes the sulfadiazine solution. No operations are done until the blood pressure has reached 100 systolic and the pulse is satisfactory in quality and rate. A thready rapid pulse makes one hesitate—more than that—just stop. We use fresh blood freely so that even the bleeding patient is not denied operation. We can give him blood faster than he can lose it. When a large vessel is hit the patient generally does not arrive here.

In connection with bowel injuries all injuries to the colon are exteriorized—colostomy in continuity. If a segment is damaged it is exteriorized as a double barreled colostomy. However if a fixed portion of the large bowel is damaged it is repaired and a proximal colostomy is done. Injuries to the colon below the peritoneal reflection (rectosigmoid and rectum down to the sphincters) are all treated with a colostomy in discontinuity. When large bowel is exteriorized because of injury or a loop of bowel (for a colostomy) is brought out the skin is not sutured but through and through (deep) sutures are employed to hold the abdominal wall together. I put dry dressings on but vaseline gauze dressings are advised. A frosting of sulfanilamide crystals is used about the bowel in the wound after the peritoneum has been closed.

Bladder injuries when fresh are closed with a catgut suture and a suprapubic cystostomy is done. Old perforations are treated by suprapubic drainage of the bladder plus drainage of the space of Retzius.

Injuries of the small bowel are sutured or resected and either end to end or side to side anastomosis is done.

In all cases a Levin tube is passed and suction is commenced immediately. Hydration, nutrition, blood protein and mineral levels are maintained by intravenous injections and blood is given in adequate amounts. (Only blood takes the place of blood.) The sulfonamides are continued daily in 4 to 5 gm doses for one week and then discontinued if not necessary; otherwise they are continued for a longer period keeping in mind the complications caused by the drug itself, the importance of an adequate urinary output and the general status of the patient.

No drains are used intraperitoneally and the abdominal wall is loosely closed with the skin left open so that no abdominal wall drains are necessary.

The sulfonamides are actually the reason for the diminished incidence of infection. It is amazing to see so many open wounds with rarely an elevation in temperature. Those who can take the magic powder by mouth do so. It is dusted (frosted) not too thickly onto all open wounds after debridement and excision of dead tissue. Those who cannot take it by mouth and have no

raw surface to receive it get it intravenously. In other words, everyone with an open wound gets it by one means or another. It is important it is life saving and bears the same relationship to infection that morphine bears to pain.

SUMMARY

The management of perforating wounds of the abdomen demands a familiarity with practically every technical procedure used in abdominal surgery. One should never venture an exploration of these patients without anticipating the many problems which may have to be met. The patients should be supported by infusions and transfusions during the operation and no patient should be brought to surgery until shock and hemorrhage have been given adequate consideration. The inventory of the surgical set up including the actual laparotomy set and accessories, should not be left to those of lesser experience but should be carefully gone over by the operating surgeon himself. It is all too easy to upset the entire operating room force by the unwitting omission of needed equipment by those who have had little experience in this type of emergency surgery.

Standardization of technic and the development of a system of exploration and management will greatly improve the results in the handling of penetrating injuries of the abdomen. In few other fields of surgery is there required a greater degree of skill and ingenuity. Experience and good judgment must be the handmaids of the operator who assumes the burden of this type of surgery.

PERITONITIS IN INFANCY AND CHILDHOOD*

HARRY A. OBERHELMAN M.D.† and 1ST LIEUTENANT OLIVER AUSTIN‡

To limit a discussion of infections of the peritoneum exclusively to infants and children may seem to some as going somewhat afar in the field of specialization. However we who have the responsibilities of the Children's Surgical Ward of the Cook County Hospital do not share such a view. In their book on Abdominal Surgery of Infancy and Childhood Ladd and Gross¹ call attention to the fact that the infant and child cannot be treated as a diminutive man or woman. They do not mean that Pediatric Surgery should be classified as a separate specialty but they do appeal to the surgical profession to require a fuller appreciation of the importance of preoperative and postoperative care and to acquire a more highly specialized and delicate operative technic. On the basis of our experience we would like to appeal further to the surgical profession to appreciate more fully the handicaps and limitations that exist in the problem of surgical diagnosis in Pediatrics. An infant cannot describe his symptoms nor does it have the highly sensitive nervous system that adults have. Pain to an adult may not be pain to the infant.

In order more fully to understand and appreciate infections of the peritoneum, a few anatomic and physiologic facts are in order. The peritoneum both parietal and visceral has a surface area equivalent to the entire skin area of the body. It consists of an inner mesothelial and an outer fibroblastic layer richly supplied with blood and lymphatic vessels and possesses a tremendous capacity for absorption. Experiments have shown that the peritoneum can absorb a quantity of fluid equal to the body weight in twelve to thirty hours. Harvey and Meleney² from a collective review of the recent literature on peritonitis believe that bacteria and particulate matter are absorbed by the lymphatics and that solutions of even large molecules are absorbed

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by the blood vessels. Any peritoneal inflammation may materially reduce its absorptive capacity.

ETIOLOGY

Peritonitis may be either *aseptic* or *septic* in origin. The aseptic form results from external or internal trauma causing extravasations of blood, urine, bile, stomach content, or pancreatic secretions. This form might well be designated as a *chemical* peritonitis. The septic form results from pathogenic bacteria. Often the septic form has been preceded by an aseptic peritonitis.

CLASSIFICATION OF PERITONITIS IN INFANCY AND CHILDHOOD

I Primary Peritonitis (General)

1 Streptococcus

Pneumococcus

II Secondary Peritonitis (Local or General)

A Aseptic Form

1 Blunt violence to the abdominal wall or viscera with extravasation of blood

2 Traumatic rupture of the gallbladder, urinary bladder, pancreas, or an abdominal cyst

B Septic Peritonitis

1 Descent of the gastrointestinal tract

(a) Acute appendicitis

(b) Gangrenous ulcerations of the bowel, intestinal obstruction, volvulus, or strangulation

(c) Ruptured peptic ulcer of the stomach or duodenum

(d) Rupture of typhoid ulcers

2 Traumatic perforation of the abdominal wall and bilious ascites

3 Gonorrheal salpingitis

4 Postoperative

(a) Contamination at operation

(b) Foreign bodies left in abdomen

(c) Leakage at intestinal anastomosis

5 Tuberculous peritonitis

Peritonitis may occur as a *primary* or *secondary* form. The primary form is rare and according to Ladd and Gross about two thirds of the cases occur within the first four years of life. It is caused by a single organism, either by the less frequent pneumococcus or the more frequent hemolytic streptococcus. The portal of entry is for the most part undetermined. The presumption, however, is that the organisms may have reached the peritoneum either by the blood stream, the transdiaphragm,

matic lymphatics, the intestinal tract, or the fallopian tubes. The blood stream appears to be the most likely path.

The secondary form of peritonitis is the far more common of the two and this form will receive the major consideration in this discussion. It may be either local or general and is caused not by a single organism but by two or more organisms. The source of this form of peritonitis is invariably the gastro intestinal tract and in children the most common source is acute appendicitis with perforation. Another less frequent source is intestinal gangrene due to intussusception, volvulus or strangulation. Perforation of a hollow viscus either by direct penetration or as a result of blunt violence is not an uncommon source. Spontaneous perforation of a peptic ulcer in or near Meckel's diverticulum must be kept in mind. Acute and chronic ulcerative colitis often offers a threat of generalized peritonitis. Finally, acute gonorrheal salpingitis on rare occasions may produce a generalized infection of the peritoneum.

On the other hand, conditions commonly causing peritonitis in adults which rarely if ever obtain in infants but may occur in children are a perforated peptic ulcer of the stomach or duodenum, a perforated infectious gallbladder, an acute sigmoid diverticulitis with perforation and an acute pancreatitis.

PREDISPOSING FACTORS

There are certain existing factors which if present invariably lead to a generalized peritonitis. The first of these factors is an anatomic one and is represented by the lack of an adequate omentum. In infants and children the omentum is thin, scanty and short, never fully reaching the lower abdomen where the source of peritonitis most often exists. Yet one marvels at the striking faculty the omentum possesses in 'walling off' certain local intraperitoneal infections. A second factor is physiologic and is dependent upon the lack of acquired immunity early in life. A third factor is bacteriologic. Experimentally it has been shown by Altemeier³ that the peritoneum in guinea pigs readily resists the action of a single organism isolated from several in human generalized appendicitis peritonitis whose exudate contains both aerobic and anaerobic forms. When two or more organisms coexist the peritoneum has much greater difficulty in resisting their action. Melenev⁴ and his co-workers noted this so-called synergistic action between the three commoner organisms occurring together in generalized peritonitis—the colon bacillus,

Clostridium welchii and the intestinal streptococcus. They reported a high mortality rate in animals when all three organisms were injected intraperitoneally as compared to a low mortality when a pure culture of any one organism alone was injected.

A fourth factor that the peritoneum finds difficult to resist is mechanical and is present when a leak from a hollow viscus is continuous instead of temporary. Such a continuous leak may occur from a perforated appendix, peptic ulcer or a faulty intestinal anastomosis. Under such conditions no walling off action can complete itself and therefore a generalized peritonitis is inevitable.

A fifth and final factor in the development of a generalized peritonitis is determined by the level of the perforation in the gastro-intestinal tract. Melneva and her co-workers reported a higher mortality rate in perforations of the small bowel than in perforations of the large bowel. Thus they attributed to the digestive fluids in the small bowel and the greater virulence of the bacteria. This concept was confirmed in a series of fifty-eight patients with abdominal bullet wounds reported by Oberhelman and LeCount. Of the fifty-eight patients forty-one had perforations of the small bowel with a mortality of 49 per cent and the remaining seventeen had perforations of the colon only with a mortality rate of 47 per cent. It is generally agreed among investigators that the ileocecal region is the most infectious segment of the entire gastro-intestinal tract because the intestinal content at this level constitutes an ideal culture media by reason of its alkalinity, abundant proteins and carbohydrate substances in solution.

PATHOLOGY

The pathology of acute peritonitis is the same in both the localized and generalized forms except in extent. As in any acute inflammation there is the early stage of *hyperemia*. This occurs first in the visceral portion then in the parietal portion because the source is most often a hollow viscus where the visceral peritoneum is nearer to the field of infection.

The hyperemic phase is soon followed by the formation of an exudate that is at first serous that may or may not be bacteria free but soon becomes rich in fibrin forming a serofibrinous exudate and finally a fibrinopurulent exudate. The fibrinous content gives it its adhesive property which enables the adjacent structures to become adherent to the inflamed region and form if possible a protective wall about it. In infants and chil-

dren this is not as often accomplished as in adults. In the event that all efforts at localization of the inflammatory process have failed, then a spreading or a generalized peritonitis ensues. Loops of intestines every where become covered with a plastic exudate, adhere to each other and enclose collections of purulent exudate in various parts of the abdomen. The subdiaphragmatic space, the iliac fossa and the pelvis are common sites for such accumulations, where they form localized or residual *abscesses* often requiring surgical intervention.

Associated with a spreading peritonitis is a definite inhibition of intestinal peristaltic activity, resulting in an *ileus of the paralytic type*. Such an ileus is definitely protective, because the dissemination of the peritoneal exudate is retarded and the formation of plastic adhesions encouraged, limiting the areas from which toxins are absorbed. Coincident with the paralytic ileus there is a progressive distention of the intestine from decomposing bowel content and fermentation. When this occurs, according to Herrin and Meek,⁶ fluid is actually secreted into the lumen of the intestine instead of being retained in the tissues and circulating system. This constitutes an important factor in creating a serious state of dehydration and if not compensated for invariably results in shock.

It is a well established fact that in secondary generalized peritonitis the type or amount of the exudate does not indicate the virulence of the organisms, nor does it indicate the gravity of the peritonitis or suggest what group of organisms is responsible. The putrid odor of the peritoneal exudate so frequently noted is not due to the colon bacillus, as is so commonly assumed, but according to Altemeier's⁷ studies it is due to anaerobic bacteria, mainly *Bacillus melaninogenicum* and anaerobic streptococci.

The *character of the exudate* can suggest the organism only when the latter occurs singly. This obtains only in the primary form of peritonitis. When a pneumococcus is the causative organism the exudate is relatively thick, almost entirely fibrinous, purulent, forming layers of plastic exudation over both parietal and visceral peritoneum such as one sees in pleural empyema. When a surgeon opens such an abdomen his incision is made over the most likely area representing the source of the peritonitis, which in a child is usually the right lower quadrant, with a view of doing an appendectomy. He may find the appendix covered with fibrin and consider that the source of

the peritonitis when in reality it is involved no more than the rest of the peritoneal structures. When a streptococcus produces the primary form of peritonitis this problem does not confront the surgeon because the exudate is thin, watery, slightly turbid with only scattered flecks of fibrin.

A number of the forms of peritonitis in infancy and childhood, both primary and secondary, found in our classification have been under our care in the Children's Surgical Ward of the Cook County Hospital during recent years.

PRIMARY STREPTOCOCCAL PERITONITIS

CASE I—A female child, aged nine months, entered the Cook County Hospital on May 11, 1941, with a history of an acute upper respiratory tract infection for ten days and of abdominal distention, vomiting and diarrhea for three days. The axillary temperature on entrance was 103.4° F. Physical findings consisted of an injected throat and nasal passages, normal chest, a moderately distended and rigid abdomen with diminished bowel sounds and dullness in both flanks. The laboratory findings revealed a leukocyte count of 14,350 with 87 per cent polymorphonuclears and 13 per cent lymphocytes, red blood cell count 3,340,000 and hemoglobin 10 gm. The urine was normal. X-ray of the chest was negative and a flat film of the abdomen revealed generalized dilatation of the loops of intestine as one sees in paralytic ileus. Abdominal paracentesis yielded a small amount of cloudy fluid which on direct smears and cultures proved to contain hemolytic streptococci.

Treatment consisted of the use of a Levine tube for continuous aspiration, intravenous fluids of 5 per cent glucose in saline and intravenous sodium sulfathiazole, 1½ grains per pound of body weight for twenty-four hours. On the following day sulfanilamide was substituted using the same dosage. On the fourth day definite signs of improvement appeared. During the third week of hospitalization a subcutaneous abscess developed in the right thigh. This was opened and drained and a pure culture of hemolytic streptococcus was recovered. In six weeks the patient was discharged from the hospital.

The history and physical findings were most suggestive of an acute appendicitis associated with an upper respiratory tract infection. However, since the child had been ill for ten days, conservative supportive measures seemed warranted. The recovery of a pure culture of hemolytic streptococcus from the peritoneum by aspiration was most significant and useful in establishing the diagnosis of primary peritonitis. Ladd⁸ and his associ-

ares advocate making a small incision for recovery of the organism instead of a paracentesis and at the same time establish peritoneal drainage. The purpose of recovering the organism at the earliest possible moment is to institute sulfanilamide therapy as soon as possible by mouth or intravenously. We feel that this sulfonamide therapy was the turning point in the patient's recovery.

PRIMARY PNEUMOCOCCAL PERITONITIS

CASE II—E. K. a girl aged eleven years entered the Cook County Hospital February 25, 1943 with a history of cramping pains slightly greater on the right side associated with nausea and vomiting for six days. Temperature was 102.8 F, pulse 160 and respirations 28. Positive physical findings were a distended abdomen the width of two fingers above the suprapubic line, tenderness and generalized rigidity greater in the lower half. X ray of the chest was negative. Leukocyte count was 13,500 with 75 per cent polymorphonuclears and 25 per cent lymphocytes; the red blood cell count was 3,760,000. The urine was normal.

Under conservative management, such as continuous gastric suction, intravenous fluids and sulfathiazole and blood transfusions, the child's condition improved only slightly. Two weeks after admission an abdominal paracentesis was done for a suprapubic mass and 300 cc. of thick greenish fluid was removed which on culture yielded a pure growth of Type I pneumococcus. Also at this same time a second X ray of the chest was taken and this revealed infiltration of the right lung which later developed into an abscess. The child's condition grew progressively worse and she died eight weeks after admission.

One might question the validity of a diagnosis of primary pneumococcal peritonitis in this patient. However, the symptoms were entirely abdominal for the first two weeks, a definite suprapubic mass being present. During this time the chest findings were negative both by X ray and physical examination. It was not until seventeen days after the onset of symptoms that positive chest findings were found. We believe therefore that this case represents a primary pneumococcal peritonitis with the chest findings as a secondary complication. Entry was no doubt by way of the vaginal and tubal routes since a suprapubic mass appeared first.

In the treatment of this condition antipneumococcus serum was not used. The diagnosis was not made until almost three weeks after the onset at which time serious chest complications

had set in. It is possible that with early abdominal drainage and antipneumococcus serum therapy the end results might have been favorable.

GONOCOCCAL PERITONITIS

CASE III—M. H. a girl aged twelve years entered Cook County Hospital on December 23, 1942 with a temperature of 101° F, pulse 140 and respirations 20. She had had cramping pains of increasing severity for three weeks which now had become a steady pain in the lower abdomen associated with burning on urination, nausea and vomiting. A white vaginal discharge was noted two weeks before the onset of pain. The essential physical findings were tenderness over the entire abdomen with much rebound tenderness of both lower quadrants. Bowel sounds were definitely diminished. There was a copious thick whitish vaginal discharge which on smears revealed a large number of gram negative intracellular diplococci. Rectal examination revealed a tender boggy mass in the cul de sac. The urine was negative, red blood cell count 4,260,000 with hemoglobin 12 gm, leukocyte count 11,600 with 70 per cent polymorphonuclears, 22 per cent lymphocytes and 2 per cent mononuclears.

The patient was given fluids and sodium sulfathiazole 4 gm per day intravenously. She was placed in Fowler's position with an ice bag to the abdomen. She improved promptly; the boggy mass in the cul de sac had disappeared by the tenth day and in four weeks the child was discharged from the hospital.

This case is fairly representative of the acute form of gonococcal peritonitis. All cases that we have seen in our wards have been secondary to a gonorrheal vulvovaginitis and salpingitis. The organisms enter the peritoneal cavity either through the fallopian tubes or the lymphatic plexus draining the vulva and vagina. The vaginal discharge is usually of the thick creamy type and more often than not contains gonococci. The exudate in the peritoneal cavity is likewise thick and tends to localize in the pelvis where dense adhesions develop between all the pelvic structures. The management is obviously conservative and the condition requires from two to four weeks for recovery with the aid of intravenous fluids and sulfonamide drugs.

PERITONITIS SECONDARY TO INTESTINAL OBSTRUCTION

A not uncommon source of secondary peritonitis in children is from a late unreduced intussusception, volvulus or other intestinal strangulation. In these conditions the peritoneal fluid at

first is sterile and initiates a chemical or aseptic peritonitis. However as the obstructive process continues degenerative changes soon develop from trauma and circulatory interference allowing bacteria to penetrate the intestinal wall without evidence of gross perforation. This converts an aseptic peritonitis into a septic and generalized one. Complicating such a condition in the bowel wall is the associated intestinal obstruction which adds much to the gravity of the situation. Any surgery at this time must of course be directed at relieving the obstruction. This will require an exteriorization of the involved bowel with resection and subsequent anastomosis. Sulfanilamide and sulfathiazole 2 gm each should be introduced into the peritoneal cavity before closure. To drain the peritoneal cavity under these conditions has little or no value in our opinion. Great emphasis however is placed upon the general supportive post operative management.

APPENDICITIS PERITONITIS

By far the most common source of secondary peritonitis in children is acute appendicitis. Approximately 75 per cent of all forms seen in our Children's Surgical Ward is the result of such an infection. As peritonitis of this origin is always a complication of acute appendicitis one cannot escape some discussion at least of the management of acute appendicitis. If it were possible to operate early on every child with acute appendicitis we would eliminate the most common cause of peritonitis in children. In other words early and prompt surgery for acute appendicitis is the best prophylaxis against appendicitis peritonitis but unfortunately too often the child is brought to the hospital too late to avoid this complication.

Appendicitis peritonitis occurs in one of two forms one a *localized form* represented clinically by a tender palpable mass in the right lower quadrant or near the umbilicus the other a *spreading or generalized form* characterized clinically by generalized tenderness, rigidity and tympanitis.

The studies of Miller⁹ and his associates of acute appendicitis in children stimulated our interest in appendicitis peritonitis. Since their report we have reviewed an additional series in the same Children's Ward of Cook County Hospital following through with the treatment outlined by them for the most part

Localized Form of Appendicitis Peritonitis

Of the localized form of appendicitis peritonitis two types occur which cannot always be clinically differentiated at first. Both types present the same symptoms and physical findings. A palpable mass is found in the right lower quadrant. In one type the palpable mass pathologically consists of a cellulitis or *phlegmon* of the appendix with the surrounding structures adherent to it to prevent further spread. In this type the appendix is not ruptured. In the other type the palpable mass is an actually ruptured appendix with *abscess* formation that has become walled off by contiguous structures of loops of intestine, great omentum, abdominal wall, and often the pelvic structures. In the first instance we are dealing with an inflammatory induration with little if any tissue destruction, and in the second instance with actual suppuration with much tissue destruction and abscess formation.

After a week or ten days one can usually differentiate clinically between the two types of inflammation. The mass in the phlegmonous type disappears in six to ten days, while in the abscess type two to three weeks, and sometimes six weeks may be required for the mass to disappear. In other words, resolution and absorption of the phlegmonous mass takes place much more quickly than resolution and absorption of an actual abscess. The following case report illustrates the phlegmonous type.

CASE IV. Localized Phlegmonous Appendicitis Peritonitis.—E. J. a boy aged thirteen years was admitted to the Cook County Hospital on April 15, 1947, with a history of abdominal pain for two days, cramping for the past twelve hours, the pain then becoming localized in the right lower quadrant, associated with nausea, vomiting, and anorexia. Physical examination revealed a temperature of 100.6° F., pulse 110, and respiration 24. The abdomen was not distended, but tenderness and rigidity of the right lower quadrant was marked, and a mass 5 by 5 cm. was palpated here. Rectal examination was painful on the right side. The leukocyte count was 16,000, with 90 per cent polymorphonuclears and 10 per cent lymphocytes. The urine was normal.

The child was treated conservatively, and on the fifth day the mass was no longer palpable, and on the eighth day the child was dismissed from the hospital. Three months later he returned for an interval appendectomy, which was followed by an uneventful recovery. At operation a few fibrous adhesions were found about the appendix.

CASE V *Localized Suppurative Appendicitis Peritonitis*—E. H. a girl aged ten years entered the surgical ward of Cook County Hospital on November 16 1942 having been ill for eight days with cramping periumbilical pain which after eighteen hours localized to the right lower quadrant Nausea vomiting and anorexia were present as was a diarrhea for one day prior to admission On physical examination the child did not appear acutely ill She had a temperature of 100 F., pulse 110 and respirations 24 The essential findings revealed the abdomen distended to one fingerbreadth above the xiphopubic line and a localized tender and palpable mass 6 by 6 cm in the right lower quadrant Bowel sounds were slightly diminished Rectal examination was painful and a tender nonfluctuant mass was felt on the right side The leukocyte count was 17 600 with 90 per cent polymorphonuclears Conservative treatment was instituted The palpable mass in the right lower quadrant was outlined with ink each day to note its decrease in size and after twenty-one days it had completely disappeared The patient was discharged from the hospital, and approximately three months later she returned to the hospital for an interval appendectomy At operation dense adhesions were encountered and an uneventful recovery followed

By comparing these two case histories one can readily see that their difference is only a matter of degree This difference in degree assumes a significant role in the subsequent management however because it serves as a guide as to how soon an interval appendectomy may safely be done without danger of initiating a generalized peritonitis In the group with localized phlegmonous appendicitis peritonitis and in which the mass disappears in six to ten days interval appendectomy may be done in six to eight weeks without fear of causing a generalized peritonitis On the other hand, in the group with localized suppurative appendicitis peritonitis in which the mass requires fifteen to twenty one days or longer for absorption a much longer time interval is necessary before an interval appendectomy can safely be done

One might assume that as soon as the temperature and blood count have returned to normal and the mass is no longer tender or palpable that an interval appendectomy might safely be performed We have learned that when these findings exist resolution and absorption have not as yet completely disposed of the mass Miller and his associates have suggested a time interval of three months It is interesting to note that we have encountered some patients in our series for whom three months was

too short an interval for complete resolution and absorption to take place

In two of our patients the appendiceal mass could not be palpated until after they had been anesthetized for surgery when relaxation then permitted us to palpate the residual mass. Neither patient was operated upon but sent back to the ward for surgery at a later date. In another case the peritoneal cavity was opened before the mass could be found. It was left undisturbed and the abdomen closed. We consider that such a disposal of the case represents sound surgical judgment. Should the operating surgeon believe that something more should be done under such circumstances as an alternative drainage might be instituted at a point where the parietal peritoneum is adher-

TABLE 1

COMPARATIVE AND TOTAL MORTALITY RATES OF LOCALIZED APPENDICITIS PERITONITIS BASED ON OPERATIVE AND NONOPERATIVE TREATMENT

Series	Operated Cases				Nonoperated Cases			
	Total	Recovery	Deaths	Mortality	Total	Recovery	Deaths	Mortality
Miller et al.	23	23	2	8%	203	198	5	2.5%
Oberhelman and Austin	0	0	0	0	74	72	2	2.8%
Total	23	23	2	8	277	270	7	2.5%

ent to the mass. This allows drainage extraperitoneally which invariably is a safe procedure.

Occasionally a patient with localized appendicitis peritonitis shows signs that the local peritonitis is threatening to become a spreading peritonitis. Should such signs develop immediate surgery is indicated. One patient in our series developed a progressively enlarging mass that pointed suprapubically. Drainage was immediately established and four months later an interval appendectomy was done followed by an uneventful recovery.

In comparing the mortality rate of our series of localized appendicitis peritonitis with that of Miller and his associates (see Table 1) we find that a continuation of their conservative management has again been justified in the prevention of fatalities from appendicitis peritonitis.

While the mortality rate in our series is slightly higher than in Miller's series, yet when one considers the combined mortality rate of 25 per cent there is every reason to justify a continuation of this form of conservative management.

Spreading or Generalized Form of Appendicitis Peritonitis

A generalized appendicitis peritonitis presents a far graver problem than the localized form. The routine treatment of this condition is again essentially the same as that advocated by Miller and his associates of which the following case report is quite typical.

CASE VI—G. B., a girl, aged twelve years, entered the Cook County Hospital on August 11, 1945, because of abdominal pain of thirty-eight hours duration. At the onset the pain was cramping and periumbilical for eighteen hours, then localized to the right lower quadrant. Shortly before admission the pain became generalized again. Nausea, vomiting and anorexia were present from the onset. She had severe chills en route to the hospital. The positive physical findings consisted of tenderness and rigidity over the entire abdomen, more marked in the right lower quadrant. Rebound tenderness was generalized and both psoas and obturator signs were positive. Bowel sounds were absent. Rectal examination revealed tenderness on deep palpation on the right side. Temperature was 101° F., leukocyte count 15,500, urine negative. The preoperative diagnosis was a ruptured appendix with generalized peritonitis.

Under nitrous oxide-ether anesthesia the peritoneum was opened by a McBurney's incision. The peritoneum was first opened for 1 cm. to allow a large amount of turbid fluid to be aspirated by the Pool suction method. The operative field was packed off with lap pads and a routine appendectomy was done, inverting the stump with a purse-string suture. A Penrose drain was placed into the right lateral gutter. About 2 gm. of sulfanilamide was dusted into the abdomen and muscle layers before closure. Three so-called Army stitches of black silk were placed in the skin but were not tied. A Levine tube was passed into the stomach. A solution of 2000 cc. of 2.5 per cent dextrose in 0.4 per cent saline solution containing 4 gm. of 0.8 per cent sulfanilamide was given intravenously daily for eight days and on alternate days a supplementary transfusion of 250 cc. of blood was given. The skin sutures were tied to close the wound on the third day. The Levine tube was removed on the fourth day when bowel sounds had returned. Recovery was uneventful.

It is our conviction that immediate surgery, if general conditions permit, is the treatment of choice, using simultaneously all

the general supportive measures available. If the patient enters the hospital in impending shock we believe surgery should be deferred until supportive measures have revived the patient sufficiently to make him a better surgical risk. We feel that the same therapy employed in a perforated gastric ulcer or other intestinal perforation producing a generalized peritonitis should be employed in the case of a perforated appendix that is producing a spreading peritonitis. In other words the leak must be stopped because continuous leakage whether from the intestine gallbladder or urinary bladder produces a rapidly fatal generalized peritonitis unless such a leak is stopped promptly.

We appreciate the fact that every ruptured appendix does not mean a continuous leakage. This is particularly true when the rupture is in the distal two thirds of the appendix because there is enough edema of the appendix wall proximal to the perfora-

TABLE 2

COMPARATIVE MORTALITY RATES WITH NONDRAINAGE AND DRAINAGE OF THE PERITONEAL CAVITY

Treatment	Number of Wounds	Clean	Infected	Mortality
Nondrained	51	21	30	58%
Drained	90	15	75	55%

tion to act as a stopper to any further leakage except that which occurred with the initial perforation which the great omentum and adjacent loops of bowel are usually able to wall off.

On the other hand when the perforation is near or at the base of the appendix continuous leakage is more likely to occur from the cecum followed very soon by a generalized appendicitis peritonitis requiring immediate surgical intervention. It is our belief that a leaking appendix of this type causes most of the instances of generalized peritonitis while those with only the initial leak account for most of the localized forms.

The question of *drainage* has long been a matter of dispute among surgeons. There probably will never be a common view on this question. We believe that a drain into the peritoneal cavity is indicated when at the time of operation a continuous leak from the ruptured appendix is demonstrable or when the appendix is too inaccessible to warrant its removal in the pres-

dren with acute appendicitis 306 had a generalized appendicitis peritonitis of which 281 were operated upon immediately with a mortality of 12.7 per cent. The mortality of the remaining twenty-five not operated upon was 80 per cent. In our somewhat smaller but later series of 680 children with acute appendicitis 165 had a generalized appendicitis peritonitis and were operated upon immediately excepting one with a mortality of 7.4 per cent. The one not operated upon died.

Since the management of both series was practically the same how can one account for such a difference in mortality rates? This may be attributed to several factors. In the first place it requires much time to develop and train a hospital personnel to carry out effectively and efficiently any new program of management. It is therefore not presumptive to state that when this program of management was first instituted the resident and attending staffs were not as familiar with the details of management as they were after the program had become an established routine. In other words our series had the benefit of an already established program with which our resident and attending staffs already had acquired complete familiarity. A second factor is possibly the more general routine use of the sulfonamides which were not so readily available in the earlier part of Miller's series. A third factor is that our series had the benefit of a more adequate supply of available blood and plasma for purposes of transfusion. A fourth and speculative factor is that our series is not as large as Miller's and if it were as large the mortality rate might be different.

The encouraging factor common to both series is the progressive reduction in the mortality rate of acute appendicitis peritonitis whether localized or generalized, this rate being the lowest yet obtained in the children's Surgical Wards of Cook County Hospital. It becomes the more gratifying to see this accomplished in a large charity institution which is a training ground for surgeons whose surgical judgment required in emergencies is often immature and whose operative technic is still in process of perfection.

CONCLUSIONS

1. It is our conviction that the general surgeon is not fully appreciative of the factors governing peritonitis in infants and children.

2. We consider it most essential for the surgeon to be

thoroughly acquainted with the anatomy, physiology and pathology of the peritoneum in order to realize fully the symptoms of peritonitis

3 A classification of peritonitis in infants and children is presented and the several forms discussed

4 The treatment of primary peritonitis tends toward conservatism with the aid of sulfonamides and blood and plasma transfusions

5 The character of the exudate in peritonitis reflects the causative organism only when the latter occurs singly groups of organisms never reflect their identity by the character of their exudate

6 Since acute appendicitis is responsible for peritonitis more often than all the other causes combined its discussion is dealt with at some length

7 A distinction between the localized phlegmonous appendicitis peritonitis and the localized suppurative appendicitis is possible and it serves as an index as to the time when appendectomy may safely be done to avoid appendicitis peritonitis

8 The conservative management of localized appendicitis peritonitis and the operative management of a spreading or generalized appendicitis peritonitis have justified themselves again by the progressive fall in mortality rates obtained by these forms of management

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FOREIGN BODIES IN THE PERITONEUM

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THE peritoneum assumes the importance of an independent organ which is vital in both health and disease. In lining the abdominal cavity in closely investing more or less completely the abdominal viscera it exhibits a most complex topography and an area somewhat greater than that of the surface of the entire body. It is an entirely closed sac in the male; in the female it is likewise closed except through communication externally by means of vagina, uterus and fallopian tubes.

Primary disease of the peritoneum is uncommon but secondary disease of this organ is an important factor in nearly all types of intra-abdominal disorders and especially those of the gastrointestinal tract. The disease may be initiated by the lesion itself or by disturbed visceral function, but sooner or later the dominant symptoms are associated with peritoneal involvement. Early diagnosis of surgical lesions is frequently possible and always desirable before the later or so-called peritoneal stage has been reached.

ANATOMIC AND PHYSIOLOGIC CONSIDERATIONS

The intricate assembly of folds, bands, spaces and fossae in the normal peritoneum has its significance in the localization of infections, the occurrence of adhesions and the development of internal hernias. The duplications of the mesentery and the great omentum with their complicated vascular and nerve supply have little importance. The subphrenic space, the lesser peritoneal cavity, the subhepatic space, the fossa of the midabdomen and the lower peritoneal pouch called the pelvis, through their varied anatomical and physiological relationships influence the pathologic changes produced by foreign bodies.

The peritoneum has greater absorptive power of water than have the stomach or intestine. An animal may in twenty-four hours absorb through its peritoneum an amount equal to its body weight unless limited by other physiologic considerations.

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This marked absorptive ability is shown not only in the assimilation of possibly much needed liquids but also in absorption of poisons and toxins. These may be present in foreign bodies.

Our former conception that the *absorptive power* of the upper abdominal peritoneum is greater than the lower has been disproved. The real virtue in the Fowler position in certain acute abdominal pathological conditions does not depend upon this factor of absorption but rather upon the improved ability of the peritoneum through gravity to localize infection in this position and to do this in an area more accessible than that of the upper abdomen with its vital parenchymatous organs.

The rate of absorption is influenced by the character, the temperature and the concentration of the material being absorbed, the amount already assimilated and the degree of irritation or inflammation present. The rate is lessened by increased intra abdominal pressure, by decreased peristalsis and by poor local or general circulation.

Free blood in the intact peritoneum may be absorbed fairly rapidly but coagulation retards this process. The coagulation itself is increased by an irritated peritoneal surface. The blood clot becomes a foreign body and produces peritoneal irritation and aseptic inflammation. Polynuclear and round cell infiltration occurs and slowly the mass may disappear through phagocytic activity. If bacteria are present the clot becomes a fertile culture media and suppuration probably results.

Equal to the absorptive power of the normal peritoneum is its *exudative capacity*. In health these two qualities counterbalance or reinforce each other and result in the presence of a small amount of free fluid and a smooth glistening frictionless surface with no tendency for adjacent peritoneal surfaces to adhere. Anything that may change this relationship or control immediately destroys this fine lubricated surface with a complexity of effects depending upon many factors.

PATHOLOGY AND PATHOGENESIS

A foreign body in the peritoneum will at once affect its physiologic balance. If the trauma produced is *aseptic* the peritonitis is of that type but it is prone to become *infective*. The irritation of chemicals, the mechanical injury of external violence or trauma induced by operative handling are other frequent causes. Peritonitis due to the escape into the peritoneum of blood, gastric juice, bile, contents of cysts, pancreatic secre-

tion urine and even air and water may likewise be noninfective at first. These substances may virtually become foreign bodies also. The distinction between aseptic and infective peritonitis is less noted clinically than pathologically. The early clinical course is usually indistinguishable.

When acute infection develops the peritoneum changes from an absorptive to an exudative surface. It becomes red and injected. It exudes serum and plastic exudate. The serum becomes turbid and later purulent. Adjacent surfaces adhere to each other. The omentum is attracted to the spot and aids in walling off the infected area. This may contain a foreign body. The protection afforded by this exudative process may be destroyed by sponging and tearing up the fresh adhesions by rough handling by irrigation or even by exposure to air. The peritoneum should remain exudative and not be permitted to become a raw absorbing surface that will soak up the toxin produced by the infection.

The toxemia produced by the peritonitis retards or arrests peristalsis. The reaction of the parietal peritoneum is to produce a rigid contraction of the covering muscles of the abdominal wall. Thus nature provides without interference on our part the ideal conditions for fighting the infection, namely the walling off processes, support and protection, and above all else rest. Foods and laxatives and other agents that increase peristalsis may spread infection and interfere with its localization.

In any consideration of foreign bodies in the peritoneum the *omentum* cannot be ignored. In different individuals this may vary greatly in size and shape as well as in blood vessel supply and fat content. Its efficiency will naturally depend on these factors. It has been demonstrated that other tissues which have been deprived of their normal blood supply through one cause or another have remained viable through the vicarious blood supply furnished by adherent omentum. Because of its protective qualities omentum is often utilized as a covering over suture lines and traumatized peritoneal surfaces. Its presence and function have given rise to much conjecture. It has similar absorptive and exudative qualities to the rest of the peritoneum and is an important factor in the defense mechanism. How often has its name "abdominal policeman" seemed justified! Its almost intelligent and selective ability to migrate to the point of attack and then envelop the enemy in a more or less complete isolation has seemed truly remarkable. The physical and physiological factors responsible for this may be enumerated as gravity

peristalsis, diaphragmatic excursion the local circulatory changes incident to inflammation, and the prompt and free exudation of fibrin at the point of contact with adjacent irritated peritoneum. Almost equal to the ability of the omentum to surround a foreign body or an infected focus is its power to disengage itself after the battle is won. After the removal of the foreign body the drainage of an abscess, or the spontaneous resolution of an infiltrated infective area and mass of exudate subsequent examination may show that the omentum is free and that it has resumed its former integrity as a cooperative unit in the defense mechanism against foreign bodies and infection.

Not all adhesions omental or otherwise detach themselves spontaneously upon the subsidence of the infection or the removal of the foreign body. Whether the adhesions are congenital and therefore probably of simple type or whether they are acquired and more complex they may cause trouble. When they are causing obstruction or other serious clinical manifestations the surgical indications for their separation are clear enough. However, in routine abdominal surgery many broad adhesions may be observed that are doing no harm and have no relationship to the clinical picture. The present trend of good surgery is to leave many of these broad bands alone. Unnecessary interference may lead to future complications.

One is impressed many times by the *resistance of the normal peritoneum to infection*. Active bacteria coming in contact with it are usually destroyed. Its visceral surface forms the limiting wall of abdominal organs which constantly harbor large numbers of bacteria and contamination of the peritoneum itself frequently occurs during abdominal operations with no resulting apparent peritoneal infection. The same amount of contamination may produce serious wound infection in the abdominal wall. This immunity of peritoneum to infection does not exist in the presence of tissue damage, foreign bodies and bleeding. The deciding factors are the quantity and virulence of the bacteria, the degree of lowered local resistance through trauma of foreign body or other origin and the culture media furnished by blood and dead tissues.

Peritoneal exudate is composed of serum, fibrin and cells in varying proportions dependent upon the cause and duration of the peritoneal irritation. If that irritation is of the mild type as from an aseptic foreign body the serum predominates with some fibrin present. If active infection is present the exudate

will be largely fibrin and cells. The fibrin is vital in the formation of the adhesions which limit the infection. The process thus becomes essentially extraperitoneal. By this limitation and by the encasement of the active area of inflammation the toxins absorbed by the blood stream and lymphatics are greatly reduced. If the infection is a virulent type however and especially if complicating elements such as foreign bodies are present or if there are other causes of pressure and strangulation infection may spread so rapidly that the defense mechanism is overwhelmed. A general peritonitis may result. The violence of the infection with little or no fibrin present in the watery inefficient exudate may even preclude the formation of adhesions.

Noninfective irritations and inflammations are more likely to be followed by permanent adhesions than are infective ones. This is because of the difference in quantity and quality of the fibrin element in the different types of inflammation. The fibrin in the aseptic type helps form connective tissues which become firm adhesions. The more granular fibrin in severe septic exudate may be entirely absorbed if the patient recovers. In encountering the various types of adhesions in abdominal surgery it is interesting and sometimes useful to know this trend in their formation.

There are some difficulties in explaining the sensitivity of the peritoneum. Injuries as by foreign bodies cause pain if the injury is to the parietal peritoneum. So does inflammation and the pain is increased by movement or manipulation. The pain is located at the point of inflammation. The visceral peritoneum is ordinarily insensitive to pain consequently pain is not experienced if the viscera are functioning properly. Pain is a sign of trouble. The trouble for example may be in the appendix but the initial pain in the epigastrium is not strictly peritoneal. It is a reflex pain from the inflamed appendix. Later there may be peritoneal involvement and peritoneal pain. A foreign body pressing and traumatizing a viscus may not cause pain and if pain is present it may not be at the point of pressure. If such pressure is against the parietal peritoneum there will be pain and the pain will be at the point of pressure. Pathologic conditions which do not reach the parietal peritoneum may run a painless course. Direct trauma to visceral peritoneum as by crushing cutting or burning does not cause the reaction of pain. If this same peritoneum is placed under tension or stretched severe pain

respiratory functions are influenced. Peritoneal trauma and inflammation may thus be associated with many features of shock.

SOURCES OF PERITONEAL FOREIGN BODIES

A consideration of foreign bodies in the peritoneum in the broader sense involves a study of almost all peritoneal pathology. Not only must our consideration include foreign bodies such as sponges left unintentionally in the abdomen at operation but all of the materials such as blood and bile previously mentioned. Suture material iodoform the sulfur drugs and other therapeutic materials whether used to combat infection to destroy diseased tissue to prevent the formation of adhesions or to combat shock and improve circulation all may at times be considered as foreign bodies in the peritoneum because it is not their regular habitat. Even bacteria in the peritoneum are foreign bodies. All of them will have some influence on the two prime powers of the peritoneum absorption and exudation.

An irritation or a secondary peritonitis may originate from injury by or inflammation associated with foreign bodies. Perforation rupture leakage and infection may follow.

Appendix

A foreign body in the appendix is the outstanding example. In my experience the fecal concretion or other fecal element in the appendix has caused far more serious results when it breaks through into the peritoneum than all other foreign bodies combined from whatever source. Other materials which might be thought of as more foreign than a fecalith may be occasionally responsible. In my series two cases of acute obstructive appendicitis one of them with perforation followed within seventy-two hours of the ingestion of barium meals. Some other cases exemplify how the foreign body may penetrate the appendiceal wall and produce a local or diffuse peritonitis. A sharp piece of calcium carbonate in the case of a young girl a fish bone in the case of a boy of fourteen a piece of probable chicken bone in the case of a boy of eight are examples. A man of fifty-five years with spreading peritonitis in which two small masses identified as bristles from a toothbrush were lying at the base of the perforated appendix is another. The case of a young farmer in which a stiff pig's hair or bristle was seen penetrating through the appendiceal wall which otherwise showed no change except for the local peritonitis present was interesting. This man later

gave a history of having done his own pork butchering and eating freely of the sausage. These patients all recovered.

Biliary Tract

Traumatic rupture or perforation and infection in the gall bladder and ducts may lead to escape of stones or bile which become foreign bodies in the peritoneal cavity. An unusual case now first reported was that of a woman of fifty years who entered the hospital with a history of supposed severe gallstone attacks for two days but these attacks were associated with unusual shock and near collapse. At operation the abdomen was found filled with blood from a laceration of the cystic artery by a sharp edged stone. With other stones this one had perforated through the ampulla of the gallbladder. In spite of transfusions and other measures the patient did not survive.

Miscellaneous Sources

Other conditions producing peritoneal irritation or infection and in which foreign bodies might be considered to be at least in part responsible may be listed as follows:

1 Stomach and duodenum. Ulcer with trauma and perforation carcinoma chemicals acting as caustics foreign bodies.

2 Intestines. Perforation from typhoid tuberculosis carcinoma diverticulitis and foreign bodies.

3 Pancreas. Hemorrhagic and necrotic inflammation. The areas of fat necrosis themselves virtually become foreign bodies in the peritoneum.

4 Liver. Abscess or hydatid cyst which may rupture.

5 Pelvic organs. Aside from pelvic infections ectopic pregnancy cysts of various types including dermoids and the trauma incident to labor there are a considerable number of reports of instances in which a foreign body has entered the peritoneum in attempted abortions.

6 Infections and abscesses may break into the peritoneum from adjacent structures e.g. perinephritic abscess abdominal wall abscess.

7 Traumatic perforations from outside as in gunshot and stab wounds perforations by probes sounds bougies and other surgical instruments used in diagnosis and treatment.

FOREIGN BODIES LEFT IN THE ABDOMEN AT OPERATION

The subject of foreign bodies left unintentionally in the abdomen deserves special consideration. It is an important subject from the standpoint of the patient the surgeon the surgical

nurses and the hospital in which the patient is confined. Others who may enter into the picture are the relatives of the patient, the insurance companies, the legal profession and the courts.

It is an intangible hazard in surgery which has been present from the beginning of abdominal operations and one that is likely to remain with us. As Schachner states in an admirable report on this subject, "It is a surgical axiom that so long as surgery continues as an art just so long will foreign substances continue to be unintentionally left in the abdominal cavity."

The frequency of this serious and regrettable accident is such as to challenge the attention of all surgeons. One may surmise from the comparatively small number of papers and discussions on this subject that it is intentionally ignored. May this attitude be prompted by the rather unpleasant aspects of the subject or does it result from a trace of the 'superiority complex'—a conviction that this accident can only happen to the other fellow and never to me? How astonished and interested does such a surgeon become when it does happen?

Our profession does not have the reputation of seeking to avoid issues. It has been characteristic of our treatment of scientific problems that we have tried to find the true solution with all its derivatives and attributes. The complexity of the issues involved in a case of foreign body left in the abdominal cavity unintentionally may leave one figuratively gasping for breath. What solution of the problem is ethical and just to the patient and all others concerned and violates no principles of right and wrong? There are so many aspects to the problem that a just solution at times seems impossible.

Reported Cases

Schachner by means of correspondence with a large number of the most prominent surgeons of his period (1901) secured their reactions on the foreign body problem and states: "Correspondence as a whole represented a display of courage and frankness that was indeed refreshing. This degree of frankness is shown by the fact that all but four who reported to him said they had left one or more foreign bodies in the abdomen."

The earliest comprehensive discussion and review of this subject was by Neugebauer in 1900. Although abdominal surgery was then in the adolescent stage of its growth, his investigations and comments are still up to date and useful and have been the foundation of subsequent reports by other writers. Schach-

ner Crossen Keefe White Greenhill and others have in turn added to the list of reported cases and offered instructive comments and suggestions. Crossen continued his interest in the problem and in 1940 brought together in one comprehensive volume most of the reports of cases found in medical literature with a well organized discussion of the entire problem. He reports 307 cases in which a sponge or sponges was left in the abdomen ninety five of forceps and twenty six of other instruments and miscellaneous articles. Among the latter was a diamond ring in one case and a pair of spectacles in another. This latter patient had been operated upon three times first in America then in Germany and finally in France. The spectacles were found in the abdomen by the French surgeon and the German surgeon was sued for damages.

Why Other Cases Are Not Reported

These 408 cases in Crossen's compilation of course represent only a small percentage of the actual instances in which a foreign body has been left in the abdomen. What are the factors in the recognized cases that cause them to be unreported? We might outline these as follows:

- 1 The facts of the case are withheld for the protection of the surgeon himself or some other surgeon who had operated previously or for the protection of assistants, nurses and hospitals. It may sometimes be true also that the withholding of such facts is to the benefit of the patient himself. The knowledge of the condition may give rise to neuroses of various types which even a judgment in a court of law will not relieve. Again when the condition is known to the patient or his relatives and they seek redress as Greenhill remarks. The large majority of malpractice suits for foreign bodies never reach the courts because for obvious reasons they are settled out of court. Whether they are settled in court or out very few will be recorded in the medical literature.

- 2 Many cases occur in which the facts are not withheld or misstated but because of the relative unimportance or minor effects of the foreign body the cases are not reported in the literature.

- 3 A considerable percentage of cases first recognized at autopsy are never reported. The element of protection may enter here but on the other hand in some cases the presence of a foreign body may have had no bearing on the cause of death.

The number of unrecognized cases is of course entirely problematic. The increased percentage of autopsies performed in modern hospitals naturally reduces the number of these unrecognized cases. At the same time there are undoubtedly many others who may harbor a foreign body for years with or without symptoms but in whom it will never be discovered.

The Attitude of the Public

The attitude of the public on the finding of foreign bodies in the peritoneum must be considered. A surgeon may make a mistake in judgment or in technic in operating upon a case. This may become known to the patient or his friends and be the cause of criticism. However they are most likely to stop there and the mistake which may be a matter of difference of opinion will be forgiven or overlooked. Not so if the mistake is the leaving of a foreign body in the abdominal cavity. This concrete evidence of possible carelessness is at once considered inexcusable and begets a spirit of belligerence and noncooperation at its very worst. Even though the object may have been harmless the patient is out 'to get the doctor'.

The accomplishments of surgery great as they are may be overrated by the laity. It may be embarrassing to the surgeon to be held as a superman who can accomplish the impossible. The realities are not recognized and the difficulties and responsibilities of a conscientious surgeon not fully appreciated. A surgeon may occupy a very exalted position in the mind of a layman until a lost foreign body is found. His descent then becomes rapid and abrupt. The attendant publicity is likewise apt to be very harmful to his reputation with the general public.

When a patient places himself in the hands of a surgeon for operation it is implied that the surgeon will do his best in the case but it is also implied that the patient will accept certain risks that cannot rightfully be transferred to the operator. In other words the surgeon cannot be held responsible for every thing that may happen. In spite of science and progress there are some risks that cannot be entirely eliminated.

Why Foreign Bodies Are Left in the Abdomen

What possible excuses may a surgeon have for leaving foreign bodies in the abdomen? His job is to perform the operation and various factors may influence his conduct.

First it may be an emergency operation.

He cannot accurately foresee what he will find or what he will do about it

He is trying to save a life and is concentrating all of his powers on that

His environment may not be ideal operating room equipment lighting instruments assistance nurses anesthesia may be deficient in some particulars

Difficulties of the operation with hemorrhage perforations pus or other fluids may demand his complete attention

He is not properly equipped to count sponges instruments and so forth while the operating nurse is

We have all been impressed many times by the ease with which a foreign body such as a sponge may disappear from view during an operation. This may be due to the manipulation of the surgeon's hands intestinal peristalsis the straining and rigidity of abdominal muscles possibly associated with vomiting and the intricate arrangement of pockets in the peritoneal topography

The carelessness of the surgeon in placing sponges and removing them and in using sponges and instruments that are too small is not an excuse but may be a fact

Clinical and Pathologic Picture

In Crossen's 307 case reports of lost *sponges* approximately one fourth of the patients died. What better proof may be offered of the serious nature of this accident?

The effect of a foreign body upon the peritoneum will depend upon several factors. (1) Its size. Naturally a large sponge or a long instrument produces more pressure. (2) Its character. It is irregularly shaped or are there sharp points in its contour? (3) Its density. A soft sponge does not produce much pressure. (4) Its location. (5) Its sterility or lack of it. This is a most important factor. (6) The individual tolerance. Like foreign bodies do not always produce like results. Some patients with foreign body peritonitis recover while others with the same type of infection do not. (7) The individual behavior. Activity increases the hazard rest diminishes it.

It is conceivable that a sterile foreign body may be so located in the peritoneal cavity as to cause no symptoms. Even this however will be associated with a degree of aseptic irritation of the adjacent peritoneum with subsequent plastic exudation adhesion formation and encapsulation.

Active bacterial infection will include the preceding changes and probably result in the formation of an abscess or a spreading peritonitis

A third process is that of extrusion of the foreign body along the line of least resistance. This may not be possible but if the foreign body is pressing against hollow viscera such as the intestine or bladder through the combined action of the inflammation the abscess the circulatory disturbances and the ulceration the foreign body may be extruded into the intestine and later passed by rectum. This occurrence is reported many times in medical literature. Instead of passing in toto it may lodge as an obstruction which will require an operation to relieve it. Instead of entering a hollow organ or causing an obstruction it may be extruded through to the body surface.

The same pathologic processes enter into the picture when a sinus or fistula is formed. As long as the foreign body remains the fistula will likely remain also. A great variety of pathologic and clinical conditions may result. The kind of lesion associated with a sponge may suggest its location.

Crossen in the analysis of his cases classifies them as to the period elapsing between the time the sponge was left in the abdomen and when it was found. The length of this period greatly influences the pathologic and clinical picture.

When a sponge is in the abdominal cavity less than a week it is unlikely to produce serious symptoms. Even if found at autopsy it is probably not responsible for death. If inflammation is present it is probably not caused by the sponge although the sponge may be an element in its spread and severity.

When the time interval is extended to a month the foreign body becomes increasingly important in the persistence of the inflammation. A wound which should have healed may suppurate and some pressure symptoms be manifest. Death during this period may be due to the original disease or postoperative complications or to the persistent infection. The sponge still may be of minor importance.

With a greater interval of time the sponge becomes progressively more important as a cause of symptoms. By this time the effects of the disease for which the operation was performed should have mostly disappeared. The acute inflammation has become chronic. The sponge produces the persistent discharging sinus or fistula or it may have become completely walled off or even have tried to enter the bowel and eliminate itself. There

may be signs and symptoms of deep residual infection but the mechanical effects of the long continued pressure and circulatory disturbances are indicated by bowel obstruction and other intestinal symptoms. The pressure may obstruct a ureter as in the author's case to be described. These are the cases which present a picture indicating advisability of a secondary operation.

In a few instances the sponge may become so encapsulated in a so called "silent area" as to produce no symptoms and it is only discovered incidentally at an operation for another complaint or at autopsy.

The sponge long present in the peritoneum becomes enclosed in a pseudomembrane which may be easily mistaken for a wall of a cyst. The sponge itself may be little changed although permeated with exudative and granular material. It does not become calcified unless it is in contact with the inside of the intestine or bladder. In some instances there is evidence of disintegration and partial absorption of the sponge.

Foreign bodies other than sponges produce a comparable clinical and pathologic picture. The mortality rate in *forceps* cases is greater than that of sponges. The pressure symptoms may come earlier and be more severe with perforation more frequent. Extrusion through the bowel is less likely but when it occurs a second perforation may be caused by the sharp foreign body within the intestine. Encapsulation is less likely. Secondary operations for their removal are likely to be more dangerous.

Needles both broken and intact may be foreign bodies in the abdominal cavity probably much more often than reported. They do not cause as much trouble as larger articles although resulting perforation of viscera or vessels may be calamitous. They are more easily encapsulated and extruded.

Lost *drums* are not uncommon. They produce the same picture as other foreign bodies.

Diagnosis

It is evident that in nearly every case the sooner the foreign body is removed the better. This involves as early a diagnosis as possible. The routine count of all used sponges both before and after closing the abdominal wound should immediately serve notice if one is missing. The count of instruments is not as consistently done in many operating rooms.

The occurrence of unusual and unaccountable *pain* following a laparotomy may first cause suspicion of a foreign body. Other

unexpected abdominal symptoms or findings may do likewise and indicate need of a more thorough examination, both general and special

The early inflammatory reaction is not likely to be significant because it is probably not due to the foreign body alone. Later the findings may be those of a local peritonitis with tenderness and tumefaction

The *persisting sinus* or *fistula* will arouse suspicion and the longer it persists the more cause it is for suspicion. Probing the sinus may show something of its course and length and if the foreign body is an instrument the metal click on contact may be diagnostic. Probing is sometimes a dangerous way of gaining information, however.

A *mass* may be felt that is not completely inflammatory in character. It is more doughy and less tender. Careful abdominal, rectal and vaginal examination may indicate its relations. It is likely to be mistaken for a neoplasm.

In a large percentage of the cases there will be symptoms and signs of some degree of *intestinal obstruction*. Other causes of obstruction related to the primary pathologic condition, for example a suppurative appendicitis, must be considered. If the foreign body is the main factor the obstructive symptoms tend to become worse. The opposite may be true in the case of the appendicitis.

Persistent bladder symptoms with absence of any other known cause may suggest a foreign body and cystoscopic examination may be indicated.

The *x ray* is of great importance in making a diagnosis. It may be useful from the first suspicion of a foreign body. If this happens to be an instrument or other material which casts a shadow, the diagnosis including location of the foreign body will be established. Most sponges unless they contain opaque material will not be recognized. This does not rule out the use of the *x ray*, however, in finding obstructions and pathologic changes in the pelvis and bladder. By using contrast media some of the puzzling sinus and fistula cases may be solved.

When all diagnostic methods have failed the symptoms persist and the suspicion of a foreign body is still present, exploratory operation may be advisable.

Treatment

The treatment of foreign body cases is recorded in the four words removal of foreign body. The proper time for this procedure and the treatment of complications depends upon the given case. Surgical judgment must here decide after a consideration of all the factors concerned. If the foreign body is missed while the patient is still on the operating table that is the time for its removal even though the incision has been closed. An exception would occur when the patient's condition does not justify further operation at that time. It will then be deferred until the condition does justify it.

Prevention

The ideal operating room in a modern hospital must maintain certain standards. Those standards are based upon system, simplicity, efficient training of all personnel, cooperation, proper materials and constant watchfulness. When a foreign body has been left in an abdomen unintentionally, there has been a break somewhere in this line of necessary elements. It may be at times difficult to place the blame but it is there just the same. The accident should never occur.

Many factors have contributed toward the increased efficiency of modern operating rooms and surgery itself. Among these are improved lighting facilities, better anesthesia, well cared for and more practical instruments, and the carefully selected and better trained nurses and assistants. All of these have contributed toward simplifying the surgeon's task, and no doubt have caused a considerable relative decrease in the percentage of cases in which this accident occurs. No amount of training, however, will make a superman; the opinion of the public to the contrary, and the accident will probably continue to occur. As Schachner says in his article, the more closely one is associated with surgery, the easier it is to understand the occurrence of these accidents and vice versa. We can, however, use every possible means to guard against them.

Suggested Safeguards

Among the more practical and specific suggestions for improvement may be listed the following:

1. An inflexible preoperative and postoperative accounting of all materials used. Various systems have been devised to insure the accuracy of these counts.

- 2 Improvements in technic as the use of longer instruments of larger sponges and insistence that there shall be no loose or unthreaded needles on the table or in the wound
- 3 The use of a continuous sponge as devised and recommended by Crossen The sponge is placed in a pocket in the operating sheet to which it is fixed at one end Crossen combines the use of this sponge with the use of rubber sheeting He states The continuous gauze strip takes care of ordinary sponging throughout the peritoneal cavity and the rubber sheeting takes care of the packing to keep intestinal coils out of the immediate operating field and to form a protective covering over them with a portion of the large piece of sheeting always outside the cavity This method seems to the writer the nearest fool proof of any method yet devised
- 4 The weaving of permanent radiopaque fibers into the gauze which is to be used for sponges is recommended by Lewison He remarks Fundamentally the safety of a lost surgical sponge must exist in the ease and manner of its redemption and the facility with which it can be recognized localized and readily retrieved
- 5 The use of some kind of metal firmly attached to all sponges or materials used in wiping off and mopping up procedures
- 6 Increased and more efficient use of the x ray in all suspected cases Its use before and after injecting radiopaque material into sinuses and fistulas
- 7 The use of systematic suction in sinuses in both diagnosis and treatment
- 8 The use of an endoscopic tube in exploring wide sinuses
- 9 Cystoscopic examinations and ureteral catheterizations as in the author's case to be described
- 10 The less extensive use of abdominal drains When they are used and removed in installments the absolute necessity for anchoring and accounting for all unrecovered portions must be recognized
- 11 Proctoscopic examinations and in obstructive cases the use of some decompression device like the Miller Abbott tube

- 12 Improvements in surgical technic not included in the above. For example better abdominal exposure improved hemostasis and removal of blood and pus to avoid obscuring the operative field with consequent simplification of the whole operative procedure and diminished need of so many sponges and instruments.

The Surgeon's Liability

The greatest element in the prevention of this disaster is the active unfaltering interest in the subject and the constant recognition of its possibilities on the part of the attending surgeon. To arouse such interest is the purpose of this paper. The surgeon's liability may be of two kinds. He is of course accountable for the conduct of the operation. He also frequently has the responsibility in varying degree for his environment in the operating room. His is the dominant authority. Insofar as this authority extends to the selection of equipment and personnel and to perfecting an efficient organization just so far must he accept some of the responsibility for the mistakes of that organization. This may even include a lost foreign body in the peritoneum.

Case Report

A woman aged thirty years was referred to my service at Mercy Hospital in February 1937. She gave a history of having been operated upon elsewhere for a tubo-ovarian lesion eleven months previously by an excellent surgeon. Her convalescence in the hospital following this laparotomy was fairly uneventful and the wound healed by first intention. After returning to her home however she began to have urinary symptoms with pain in the left lower quadrant. There was irregular frequency and burning and occasionally signs of obstruction. The condition became progressively worse and she finally consulted a urologist. A general urologic check up was done. The findings were those of an acute recurrent pyelitis of the colon bacillus type. There was an obstruction to the left ureter about 3 inches from the bladder. The obstruction was extrinsic in nature, was not complete but intermittent and the ureter above the point of obstruction was dilated. A mass the size of an orange could be palpated to the left of the uterus. It had the feel of a broad ligament cyst and was so diagnosed. She entered the hospital for operation for this condition.

Just preliminary to operation the urologist suggested that a ureteral catheter be passed into the left ureter as a guide to be left there during operation because of the apparent close relationship of ureter and the cyst wall. This was done and proved to be a useful procedure.

At operation a tumor mass the size of a large orange was found deeply embedded in the left pelvis. Some adhesions to the mass were found which included a loop of small intestine but the mass was dissected free and removed without great difficulty. It seemed to have a fairly well defined wall of tissue and the true nature was only shown when upon cutting through this wall a fairly well preserved sponge was found to compose the most of the mass. The patient made an excellent recovery and all urinary irritation disappeared.

CONCLUSIONS

Foreign bodies in the peritoneum are responsible for most of the lesions of this organ. These may originate within the body or be transferred from without. The anatomic, physiologic and pathologic characteristics of the peritoneum largely govern the effects.

The number of cases in which a foreign body is left unintentionally in the peritoneum at operations is much greater than medical literature indicates. It is too vital a problem to be ignored. Regardless of extenuating circumstances some one is responsible. Rightly or wrongly the surgeon is usually so considered.

In making a diagnosis in patients who have had previous abdominal operations the possibility of a lost foreign body should be kept in mind.

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APPENDICITIS*

Basic Considerations in Choice of Therapy

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ACUTE appendicitis is still a frequent cause of death but death is rare when the appendix is removed before perforation has occurred. The recent improvement in the overall mortality rate of acute appendicitis has been made largely by securing removal of the acutely inflamed appendix before perforation has taken place. Careful attention to proper therapy in the cases in which the appendix has perforated has also lessened the mortality rate in this group.

The well known tendency of appendicitis to occur in childhood and young adult life should not make its presence in the other age groups any less carefully sought for. It occurs from infancy to advanced old age. In infants and very young children the diagnosis is difficult but it should always be kept in mind as a possibility particularly in a child who shows evidence of abdominal pain, vomiting and slight fever. In these young children there is a tendency for early perforation. In the patients of advanced age the clinical picture may be more complicated but the history is usually obtainable. Here the greatest difficulty lies in the patient who himself has misinterpreted the early symptoms and often arrives for care late in the course of the disease.

ETIOLOGY

The bacterial flora of the appendix is a very mixed one. Altemeier has emphasized that the effect of perforation is not the spread of a single organism but the spread of pus in which many organisms are present in a medium of foreign insoluble fecal debris. Two or more of these organisms often show marked tendency to symbiosis. Pure cultures of such organisms as *Bacillus coli*, streptococci, *B. pyocyaneus*, *B. allaligenes* and various clostridia injected into experimental animals failed to produce

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uniformly fatal infections. Mixed cultures produced a much higher mortality rate than the combined rate of death caused by the injection of the pure culture of organisms previously isolated from appendiceal contamination. Altemeier has also emphasized the importance of anaerobic micro organisms and in particular the symbiotic growth which is prone to occur between anaerobic and aerobic organisms. The necrotizing effect of these organisms is of unusual clinical interest when the abdominal wall becomes infected. The tendency of the anaerobic organisms particularly the coli group to produce gas should be mentioned. The clinical implications of these bacterial factors are of especial importance in determining proper therapy in cases of acute appendicitis with perforation.

CLINICOPATHOLOGIC FINDINGS

An attempt should always be made to evaluate the course of events in acute appendicitis. In this way an impression may be reached as to the stage to which the disease has progressed. This is accomplished by correlating the patient's history with the physical examination and the laboratory findings. Duration of symptoms while important, should never be given first place in deciding the stage of the patient's illness for the therapy to be instituted. Correct interpretation of symptoms and findings together should lead to an accurate estimate of the stage to which the disease has progressed. This will often decide whether or not an operation is in order. In this way a necessary operation will not be neglected and an unnecessary or harmful operation can be avoided.

Early Appendicitis

The earliest known pathological change occurring in appendicitis appears to be an *inflammatory reaction* about an accumulation of inspissated fecal material in the depths of an appendiceal gland (Aschoff). Usually only one or a few neighboring glands are involved. This inflammation involving the wall of the appendix irritates the muscularis mucosa and the muscularis proper. At this time the earliest symptom of appendicitis appears i.e. *pain*, which is referred usually to the periumbilical region. This pain may extend from one side of the abdomen to the other and it is similar to the colicky pain characteristic of hyperactivity of the ileum. *It is not momentary and not fleeting.* It resembles the colic of enteritis or that associated with early

mild intestinal obstruction. Early in the disease a patient may doze off to sleep between painful attacks. During the pain the patient is unable to obtain relief by changing position and the pain is not exaggerated by change of position. The pain is rarely severe enough to require sedation.

In childhood occasionally an acute upper respiratory infection seems to be associated with the development of appendicitis (Brennemann Ladd). In such cases prodromal symptoms of malaise and mild fever may precede the onset of symptoms directly referable to the diseased appendix.

As the accumulation of pus in the wall of the appendix increases the intensity of the pain is likewise liable to increase. The cramplike pain becomes stronger and more frequent. It is prone to be associated with symptoms of gastro intestinal irritation particularly anorexia, nausea and vomiting. Characteristically the vomiting is likely to occur but a few times. Profuse vomiting with cramps tends to lead to a diagnosis of some lesion other than appendicitis. Occasionally a *diarrhea* will accompany the early signs of appendicitis especially in children. It occurs characteristically after the onset of pain whereas in gastro enteritis the diarrhea is likely to be the initial symptom followed by abdominal pain. When the gastro enteritis is severe the prostration of the patient may be marked.

Systemic symptoms of this very early appendicitis are lacking or very slight. A *mild fever* (99° F.) and a *leukocytosis* about the upper limits of normal are expected. At this stage it is still impossible to diagnose acute appendicitis although such a diagnosis may be strongly suspected if the symptoms have occurred in characteristic order and severity. A history of previous attacks which is frequently obtainable often helps point the way.

Acute appendicitis may also be caused by occlusion of the lumen of the appendix by a fecalith (Wangensteen). Its clinical course is likewise characterized by symptoms discussed in the preceding paragraph. In such cases there is likely to be much more colicky pain because there is obstruction to the appendiceal lumen which becomes rapidly filled with an exudate of a purulent nature. The leukocyte count and fever are apt to be higher than in the group in which the abscess in the wall of the appendix is the local pathologic change.

It is true that at this stage the symptoms are relatively milder than might be expected from a disease which portends such serious complications. The pain is usually not severe enough

to keep the patient from sleeping fitfully the temperature and leukocytosis are inclined to be at the upper limit of normal the associated gastro intestinal symptoms are not in themselves enough to cause any great alarm

At this point in the course of the disease, spontaneous cure is possible The abscess in the appendiceal wall may drain into the appendiceal lumen, the fecalith may be extruded and allow the accumulated purulent material to drain into the proximal appendiceal or cecal lumen Such an event results in relief of symptoms Such attacks may pass unrecognized or they may terminate rapidly without a positive diagnosis of appendicitis being made

The Stage of Localization

The development of so called *localizing signs* occurs when the inflammatory process within the appendix extends near enough to the serosa of the appendix to produce a deposition of fibrin on the peritoneal coat of the appendix When this stage is reached there is a very important change in the clinical picture The *pain* is no longer generalized It becomes localized to the region of the appendix This is usually in the right lower quadrant but may be anywhere in the peritoneal cavity depending on the stage of rotation of the cecum and the length of the appendix In addition the colicky pain characteristic of intestinal hypermotility is now replaced by the pain of localized peritonitis The colicky pain disappears since the localized peritonitis induces cessation of peristaltic contractions the pain is now constant and is aggravated by change of position

At this stage the physical findings so well known as characteristic of acute appendicitis appear *Point tenderness* localized to the area of the appendix following or immediately accompanying *rebound tenderness* referred to the appendix can be elicited *Muscular rigidity* may now become demonstrable The amount of muscular rigidity is a variable finding and may be absent

When the appendix lies *retroceally* (which is a common position) bizarre physical findings are frequent There is a tendency for the local findings to be placed far laterally even into the lumbar region When the appendix is entirely retrocecal and extraperitoneal there may be no demonstrable signs of peritonitis even though perforation may have taken place This is because there is no peritoneum involved Here the local tender-

ness particularly in the lumbar region may be the only finding. When the appendix lies *over the ureter* there may be associated symptoms referred to the urogenital tract. When the appendix is *deep in the pelvis* tenderness may be detected particularly on rectal or vaginal examination. Reflex cutaneous hyperesthesia may be an accompanying sign. It may mislead in the diagnosis because of its intensity. When present it must be differentiated from herpes zoster.

Treatment—The appendix should be removed before the anatomical integrity of the serosa is interrupted. The mortality rate is markedly elevated after the contamination of the surrounding structures by contact with the material in the abscess or lumen of the appendix. *Catharsis and delay in seeking medical help are two common factors which tend to allow the appendiceal lesion to spread.* Until the serosa is broken appendectomy is the treatment of choice in acute appendicitis. Delay is advisable only in severely dehydrated patients or where the general condition of the patient may be improved by an hour or so of parenteral therapy. This delay should not be more than a few hours.

The recently suggested use of sulfanilamide or related drugs preoperatively should be noted. The aim is to secure a saturation of the body with the sulfonamide by the time of surgical attack. This should prove advantageous in minimizing the effect of operating in an inflamed field *but must not be taken as an excuse for delay in removing an appendix* which should be taken out. However, an intravenously administered sulfonamide may wisely be given during the delay which is often necessary between decision to operate and availability of operating room facilities.

The Stage of Perforation

The deposition of fibrin on the serosa of the appendix initiates a series of changes. Occasionally little or no reaction occurs. The appendiceal lesion advancing perforates and the purulent contents of the abscess cavity are poured into the peritoneal cavity. This is particularly prone to occur in children and in adults in whom the progress of the disease is rapid. It is obviously a serious matter. The imminence of acute diffuse peritonitis is apparent. These patients rapidly develop the classical signs and symptoms of acute generalized suppurative peritonitis with but transient symptomatic relief at the moment of abscess perfora-

tion In these cases with a constant leak from the opening in the appendix, appendectomy is the only logical treatment to prevent continued contamination

It is not always easy to decide whether or not a free perforation has occurred The difficulty in excluding free perforation with continued leak influences surgeons to recommend appendectomy in cases with early peritonitis They fear the certain unfavorable outcome if the leakage from the open appendix is allowed to continue When the generalized peritonitis is well established, there is a question as to whether an attempt should be made to remove the appendix The feeling that unrecognized factors of defense may be destroyed in so doing has influenced opinion in favor of nonoperative treatment in these advanced cases The poor results of appendectomy and drainage in these cases have further strengthened opinion in favor of nonintervention in far advanced peritonitis

It is fortunate that the free perforation of an acute appendicitis into the peritoneal cavity is not the usual course of events The deposit of fibrin on the appendiceal serosa is followed in a varying length of time by agglutination of the involved structures surrounding the appendix—the viscera the omentum and the abdominal parietes This results in a walling off of the diseased organ After this has occurred when the abscess in the wall of the appendix perforates the escaping purulent material instead of being free in the peritoneal cavity is surrounded by agglutinated abdominal viscera Clinically the moment of perforation which is often dramatic in the case of the free-lying appendix is likely to be less so in the present circumstances Whereas in the perforation of a free lying appendix there may be sudden relief of pain and perhaps a chill or sudden elevation of pulse rate in the presence of a phlegmon there may be only a gradual increase in local symptoms without any sudden sign which might suggest perforation This may be so undramatic as to pass unrecognized even by a patient who is well informed and anticipating the event

FOCAL SEQUELAE OF ACUTE APPENDICITIS

Periappendiceal Phlegmon

Where localization prevented free perforation the expected reflex muscular rigidity may be exaggerated over the appendix while that of the opposite side of the abdomen may show much less rigidity This is particularly likely because as the viscera

agglutinate about the inflamed appendix the infection is in effect excluded from the rest of the peritoneal cavity. When large enough the agglutinated mass of abdominal viscera may be palpated through the abdominal wall. Occasionally this mass is palpable only when the patient is asleep. Palpation should always be carefully done before operative intervention because the mass evidences satisfactory exclusion of the appendix from the peritoneal cavity by the bodily defenses. The presence of a mass usually contraindicates immediate operative intervention unless it has been present for many days without any evidence of regression.

Such a mass of matted intra abdominal viscera about an inflamed appendix is commonly referred to as an appendiceal abscess. This is a misnomer because there is usually very little pus but a large amount of inflamed tissue present. It is an area of cellulitis a phlegmon in which the pus is scanty and much less important than the wall of inflamed tissue which encloses it. This periappendiceal phlegmon is an unusually treacherous lesion not only because its walls are made up of inflamed viscera but because it is located in the peritoneal cavity. Here injudicious interference with its tendency to heal spontaneously may result in contamination of the peritoneal cavity and lead to a generalized peritonitis. Surgical intervention in particular may produce such a result.

Treatment—The phlegmon should be treated as any cellulitis would be treated i.e. by rest heat and chemotherapy. This is the essence of the *Ochsner treatment*. Rest is obtained by strict bed rest in Fowler's position to discourage accumulations of infectious material about the diaphragm. Abstinence from oral intake with continuous gastric decompression in the presence of any tendency toward distention or vomiting is accompanied by intravenous fluid administration. Morphine sulfate should be given in amounts necessary to promote rest and comfort. Heat is given if it does not aggravate the patient's symptoms. When patients obtain relief from the use of an ice bag this is allowed. Its use is probably associated with slowing of peristalsis and less local edema and tension of the inflamed tissue. There may also be some slowing of metabolism of the inflamed tissues and their invaders.

Chemotherapy is of paramount importance. Sodium sulfadiazine should be given intravenously in doses high enough to secure a blood level of between 9 and 12 mg per 100 cc of

blood This will usually require between 6 and 9 gm per day If as with the use of any other sulfa drug the desired effect is not secured within a five or six day trial period the specific drug should be discontinued and another used During this time an adequate daily intake of fluid is essential This should include 1000 cc of physiological saline solution and 2000 cc of 5 per cent dextrose solution No more than the 1000 cc of physiological saline solution should be given in any twenty four hour period unless there has been excessive emesis or drainage from Wangensteen suction In this case the amount of actual gastric secretion should be replaced volume by volume by additional physiological saline solution added to the intravenous solutions Actual gastric secretion is obtained by subtracting the amount drunk by the patient from the amount of material obtained by the Wangensteen suction In anticipation of a possible prolonged illness blood should be drawn for blood chemical studies including nonprotein nitrogen total protein and chlorides and for typing

When given such treatment, the usual course of a periappendiceal phlegmon is as follows In a few days the localized ileus which often accompanies the process of walling off (as a result of the inclusion of a loop of bowel in the wall of inflamed tissue) subsides sufficiently to allow peristaltic waves to pass gaseous and liquid material along the gastrointestinal tract It is manifested by the passage of gas rectally This is a fortuitous sign which indicates that the patient may now take fluids orally While this fluid intake must be instituted cautiously it is usually well tolerated within a short time As soon as the patient retains a sufficient quantity of fluid intravenous alimentation may be stopped The return of nausea vomiting and distention is an indication for return to gastrointestinal suction and intravenous fluids Resumption of a semisolid to solid diet may usually be allowed relatively soon and should be encouraged because the recovery from such a lesion may be prolonged and nutrition may become a major problem

Palpation of the mass reveals that it usually diminishes slowly Such spontaneous resolution is usual During the conservative treatment the surgeon should observe the patient closely and be prepared at all times for an emergency operation if local and systemic manifestations increase suddenly because of rupture of the abscess beyond its limiting walls into the free peritoneal cavity

CASE REPORT—C. L. R. a white man entered the Research and Educational Hospitals on November 3, 1942. Although he had been troubled with malaise on October 30 and 31, he first developed cramping abdominal pain on November 1 at 10:00 A.M. The pain localized to the right lower quadrant at 2:00 P.M. and nausea and vomiting occurred once at 6:00 P.M. A cold pack allowed fitful sleep during the night and on November 2 a doctor was called. He found a normal temperature and a rigid right lower quadrant, diagnosed appendicitis and gave 70 gm. of sulfanilamide. By the evening of November 2 the temperature was 101.5° F.

The patient was not seen by me until the fourth day of his disease. At this time he stated that if anything he felt better than he had the day before. He had not vomited since November 1. His temperature was 99° F., pulse 96. Examination revealed muscle spasm which extended over the entire abdomen, decreasing in intensity as the palpating hand retreated from the right lower quadrant. Marked rebound tenderness was present and distributed much as was the muscle spasm. No palpable masses were found. The leukocyte count was 16,200.

The impression was that the patient had an early perforation of an acutely inflamed appendix and he was taken to the operating room. Under spinal anesthesia a mass the size of an orange could be felt. Interpreting this as an appendiceal phlegmon, we considered that the wisest treatment would be conservative. He was given the usual treatment consisting of intestinal decompression, intravenous fluids, intravenous sodium sulfadiazine and Fowler's position. In the ensuing days the abdominal rigidity diminished, the mass became palpable and gradually subsided. His gastrointestinal tract resumed its motility and he was allowed oral intake slowly. The recovery was uneventful.

Two months later, January 17, 1943, the patient developed cramplike pains in the epigastrium at 10:00 P.M. These pains increased rapidly in intensity until 1:00 A.M. when he entered the hospital. Vomiting occurred once. Temperature was normal, the leukocyte count was 10,000, but tenderness and rigidity were palpable in the right lower quadrant. Through a right paramedian incision the appendix was found enlarged, indurated and injected. It was obviously the seat of a very acute process. There was one firm but small adhesive band extending from the tip of the appendix to the left and attached to the mesentery of the left side. This produced a definite obstruction of a loop of ileum. This band was severed and the appendix was removed in the usual manner, inverting the stump. The pathological report was that of an acute suppurative appendicitis. The postoperative course was uneventful.

We considered that operation was strongly indicated at the time of the second attack because the appendix had not yet perforated and we felt sure that peritonitis due to perforation could be prevented by immediate appendectomy. We chose conservative treatment at the time of his first entrance because his appendix apparently had perforated forty eight hours or more previously and a local phlegmon was present.

Appendiceal or Periappendiceal Abscess

Occasionally a mass such as that described does not subside spontaneously. The patient's temperature may remain elevated and may assume a septic curve. The mass may either remain stationary or enlarge. It may also become more painful. Such a mass usually is developing a large accumulation of pus at its center and may properly be called an appendiceal or periappendiceal abscess. Fluctuation is not often palpated because of the depth at which the abscess lies. Although spontaneous resolution of the abscess is possible the more common course is perforation into one of the loops of bowel which are present in the wall of the mass. Such an event is usually announced by the sudden development of a profuse diarrhea with foul smelling stools. The patient or attendant may note that the stool is mostly pus. This sudden emptying of the abscess is rapidly followed by a subjective sense of improvement and the temperature rapidly returns to normal. The mass disappears rapidly and recovery occurs.

Treatment—We do not recommend delay to permit spontaneous drainage of the type described as a routine measure. frequently *drainage* is indicated provided it can be done without draining the abscess across the free peritoneal cavity.

Rarely the abscess will point to the abdominal wall. This is announced by the development of local edema over the mass with redness and increasing tenderness. When this occurs incision and drainage will effectively bring the process to a benign termination. The appendix should not be removed at this time unless it is readily identified in the abscess cavity. Fatalities from surgical attack at this stage of the disease usually result from failure to be satisfied with the evacuation of the abscess. Disturbance of the cavity walls or a search for an appendix may cause the flare up of an inflammatory process which was previously well controlled. When the abscess is opened it should be thoroughly evacuated of pus but this evacuation should be

done gently (preferably with a suction tip) Every attempt should be made to avoid contamination of the peritoneal cavity. A site as far laterally as possible is chosen for entry to the abscess and every anatomical layer is scrutinized to avoid accidental opening of the peritoneum on the route to the abscess. I knew of one case in which care was faultless until the actual incision for the pointing abscess was made. The surgeon remarked that he had to cross the peritoneal cavity to drain the abscess and that as soon as he found pus he drained and got out. The fatal outcome is not surprising. In the first place should the peritoneal cavity be entered the abscess should not be drained at that time unless the patient had developed chills or severe pain indicating spread of the abscess. In the second place should an abscess be drained through the peritoneal cavity in error or dire necessity the abscess cavity should be cleared by suction before the drain is inserted so that a minimum amount of actual pus is left to contaminate grossly the peritoneal cavity.

Atypical Cases

The usual time required for such focal sequelae of perforation of acute appendicitis to run their course and subside is three or four weeks. There are however occasional cases in which the mass neither spreads locally nor subsides and remains constant for a period of many weeks and perhaps months. This clinical picture is frequently explained on the basis of some other pathological lesion of the cecum (carcinoma of the cecum or one of the rarer lesions such as tuberculosis or actinomycosis). Occasionally a fecalith which escaped from the lumen of the appendix when perforation occurred may be the cause. In such a case the woody induration of chronic inflammatory tissue forms the mass. Roentgen examination may reveal a filling defect of the cecum and blood in the stool may point to the presence of an ulcerating lesion of the cecum. Exploration is usually necessary to clarify the diagnosis and relieve the patient.

Pelvic Phlegmon or Abscess

Unfortunately all the sequelae of perforation of the acutely inflamed appendix do not center about the appendix. Phlegmons which tend to follow the same course as that described for those of the appendiceal region may and frequently do occur in other portions of the peritoneal cavity particularly in the pelvis and about the liver. The probability of these complications

should be borne in mind when a patient who has had appendicitis shows a prolonged elevation of temperature, or develops a fever after the original symptoms have practically disappeared.

With a pelvic abscess the patient usually suffers but mildly. Examination reveals a patient with sepsis whose abdomen is doughy and whose lower abdomen may be mildly tender especially to deep palpation. If a palpable mass is felt abdominally it is more likely to be a distended bladder than a pelvic abscess. Rectal examination quickly shows the nature of the lesion. There is inclined to be a marked absence of sphincter tone as the abscess enlarges and there may be a small quantity of mucus which has run from the patulous rectum. The patient has little discomfort on digital examination and above the prostate (or cervix) the anterior wall of the rectum is markedly displaced backward by the presence of a bulging mass. Its consistency will depend upon the contents of the mass and the quantity of pus under pressure.

Treatment—As in other appendiceal masses the tendency of this pelvic abscess is to drain spontaneously. Rest, Fowler's position, supportive therapy and chemotherapy tend to keep the process localized. Daily rectal examinations will show the progress of the lesion. Spontaneous perforation followed immediately by foul smelling diarrheal stools and recovery is usual. The presence of a mass is not an indication for operative drainage particularly since drainage through an abdominal incision is so apt to contaminate the free peritoneal cavity.

Subphrenic Abscess

When the appendiceal contamination results in the development of pus about the liver particularly subdiaphragmatically great care must be taken to recognize it as early as possible. This is particularly important because subdiaphragmatic accumulations of pus are prone to spread through the diaphragm into the chest.

When there is neither pericecal nor pelvic cause for the elevation of fever after appendicitis the region of the liver is at once suspected. Symptoms may be lacking although phrenic irritation may be manifest by hiccough or sensory phenomenon referred to the third, fourth and fifth cervical dermatomes. The systemic manifestations of high fever and malaise are prominent. Diagnosis difficult at best must usually be made on physical examination and laboratory findings. During respiration there

may be lagging of the chest on the side of the involvement and later a fullness in the subcostal region may be noted. Palpation often reveals tenderness particularly over the twelfth rib. An elevated diaphragm, enlargement of the area of liver dullness on percussion and lack of mobility of the diaphragm on the involved side may be demonstrated. Auscultation will not be of exceptional help unless there is enough compression of the base of the lungs to cause rales. The roentgenogram should always be employed in the diagnosis. Films are taken with the patient in an upright position and should particularly show the diaphragms and the lung fields above them. In addition to the elevation and fixation of the involved diaphragm the presence of a gas containing fluid in the suspected area may be seen.

Treatment—Although there is a rare possibility of spontaneous drainage of these accumulations into adjacent bowel (the hepatic or splenic flexures of the colon) the danger of extension into the thoracic cavity is much greater. This danger makes operation for these accumulations urgent. This is in contrast to the preference for delay in other focal intraperitoneal accumulations of pus which are prone to drain spontaneously. Operations of various types and techniques have been devised to drain the infected space. Here again the watchword is to avoid spread of the infection into the pleura or into the peritoneum. The mortality figures attest the importance of avoiding these cavities. (Excellent reviews on the subject of subdiaphragmatic abscess are available.)

The difficulty in establishing a definite diagnosis explains why it is that exploration for subphrenic abscess may be unrewarding even after careful preparation. The high mortality of subdiaphragmatic abscess and the slight risk of exploration warrants the unpleasantness associated with a negative exploration. Because of the difficulty in proving that an elevated temperature is not due to an accumulation of pus above the liver a negative exploration is to be preferred to the steady downhill course and high mortality which follow an unrecognized or undrained abscess. In addition the carefully performed exploration will allow a satisfactory anatomical approach without the danger of contamination. Aspiration should not be used. When negative it may simply mean that the abscess cavity was not found and when positive the needle may have entered the abscess through a fold of either pleura or peritoneum or both and may infect them on withdrawal.

Suppurative Pylephlebitis

The most dreaded and least common complication of acute appendicitis namely suppurative pylephlebitis, is essentially a bacteremia of the portal circulation. The infected thrombi of the appendicular and right colic veins cause chills and fever and after localizing in the liver cause multiple abscesses there. These are usually fatal. The British literature in particular has mentioned curative results of ligation of the right colic veins when the diagnosis was made. Concomitant use of heparin and sulfanilamide may help reduce the mortality in these cases.

PRECAUTIONS IN SURGICAL TECHNIC

When operating to remove an acutely inflamed appendix the aim is to remove the appendix unruptured. The physical factors which influence the choice of operating conditions are many and important. Proper abdominal relaxation and an incision over the appendix which produces as little weakness of the abdominal wall as possible are ideal. Careful prevention of contamination of the abdominal wall should be as important as care to prevent perforation of the appendix while removing it. Approach to the appendix as far laterally as possible will often result in keeping the infection in the region of the cecum and the lateral flank preventing gross spread to the rest of the peritoneal cavity. This is of importance because it is not always possible to recognize a small periappendiceal abscess which is opened in removing the appendix.

Spinal anesthesia is unquestionably the most effective anesthesia for producing a relaxed abdomen and contracted bowel. It is ideal where capable anesthesiologists are available. The aim to keep the operating field as closely limited to the area of the appendix as possible makes the *McBurney* (McArthur) *incision* that of choice where the appendix is in the right lower quadrant. When through error or misfortune the field becomes grossly contaminated the tendency of this incision to close spontaneously is utilized. Here after closure of the peritoneum, the entire abdominal wall may be left unsutured. It may be dressed with a dusting of a sulfonamide powder and vaseline packs and these dressings left to be extruded as the wound heals. This is likely to occur without any elevation of fever. This will often avoid an abdominal wall abscess or a phlegmon which may spread in the muscle when the anaerobic organisms gain a foothold.

When the diagnosis is in doubt when performing an operation between attacks the right rectus incision is indicated because thorough abdominal exploration cannot be accomplished through the McBurney (McArthur) incision.

Surgeons are not in accord as to the use of *drains*. They are just as strongly contraindicated in acute appendicitis without perforation as they are mandatory in draining abscesses. When an abscess wall has developed about the appendix a drain should be used. When there is a transient peritoneal contamination a drain is more likely to encourage development of infection. When the appendix is removed in the face of a generalized peritoneal infection a drain is usually inserted although its value is doubtful. The success attending the use of the sulfonamides has led to their use in the abdominal wall as well as in the peritoneal cavity in appendicitis with perforation.

CHEMOTHERAPY

The use of sulfonamide drugs in appendicitis has been associated with significant drop in mortality. This has been strikingly demonstrated by Wattenberg and Heinbecker by Ravdin Rhoads and Lockwood by Long and Dees and by Thompson Brabson and Walker. To omit the use of sulfonamide drugs in the therapy of appendicitis is to invite septic complications which might be entirely avoided with their use. It is probable that when septic complications develop in spite of the use of sulfonamides they would have been more severe without the sulfonamide. Sulfonamides have a place in the preoperative treatment in the wound at the time of operation especially in appendicitis with perforation and in the postoperative treatment as well as in the conservative treatment of complications of perforation of acute appendicitis.

Preoperative Use—The aim of preoperative use of intravenous sulfonamides is to obtain optimum circulating blood levels by the time intervention is undertaken. The superiority of sulfadiazine has been emphasized by Walter and Cole. A blood level of 9 to 12 mg per cent is aimed at. This usually requires from 5 to 9 gm per day but the quantity will vary. The preoperative administration must be done without unnecessarily delaying the operative removal of the appendix. Since it is mandatory that adequate fluid intake be maintained the drug may well be given in physiological saline solution.

Use in the Operating Field—Four grams of sulfadiazine may

be placed in the peritoneal cavity and 2 gm in the abdominal wall. The powder should be so placed that it is in solution rapidly. When lumped in large quantities the drug may be walled off as would be any other foreign body. The use of a total of 6 gm has led to satisfactory levels in the human (Walter and Cole).

Postoperative Use—The use of sulfadiazine postoperatively should be continued until the danger of septic complications is reasonably past or until the septic phenomenon present subsides. The early dosage will depend upon the blood level which in turn is dependent upon the quantity used preoperatively and in the operative field.

Use in Patients with Phlegmons—This has been discussed in the text of the article.

In general it should be pointed out that the satisfactory therapy with sulfadiazine is dependent upon maintenance of a satisfactory blood level of between 9 and 12 mg per 100 cc. This level is safe provided satisfactory fluid intake is maintained. When the desired effect from the sulfadiazine is not obtained in five or six days another member of the sulfonamides should be tried, usually sulfanilamide.

COMMENT

As the mortality from acute appendicitis is primarily reduced by removing the unperforated appendix, the primary aim should be to remove the organ before perforation has occurred. This entails avoidance of the factors which favor perforation. When the patient is in the surgeon's hands the two common factors of catharsis and delay are easily avoided. Accurate early diagnosis, particularly by the first physician who sees the patient, secures early care. The proper appreciation of the sequence of symptoms may often rule appendicitis into or out of the picture. *Most important is the fact that pain is the first symptom.* Gastrointestinal symptoms, a mild febrile response and finally localization of tenderness follow in that sequence.

After perforation has occurred the problem greatly increased in difficulty and danger consists in the wise handling of the peritoneal cavity, contamination of which may be continuous from the perforated appendix and by a varied number of virulent bacteria. The decision as to whether appendectomy should or should not be performed depends largely upon the presence or absence of a palpable mass, i.e., perforation which is

being walled off. This mass although frequently palpable only under anesthesia contraindicates immediate operative intervention.

When conservative means of therapy are elected the dangers of noninterference must bear acutely on the surgeon's mind. In particular when an accumulation of matted intestine and pus causes increasing septic phenomena with increasing pain and ileus intervention with drainage of the pus becomes mandatory.

When interference is decided upon the principles involved in allowing escape of pus from a deeply situated abscess which may border upon vital structures must be kept in mind. In particular must the surgeon make sure that in relieving the purulent accumulation he does not contaminate the peritoneal cavity. In addition he must when possible utilize incisions which will allow the maximum amount of drainage with the minimum amount of damage to the abdominal wall. Supportive care throughout the course of the illness is important. Prolonged illness will require particular attention to maintenance of fluid intake and output, nutrition and combating anemia and hypoproteinemia. Chemotherapy skillfully used may shorten the illness and actually avoid complications.

Essentials in the Management of Appendicitis

- 1 Remove the appendix before perforation
- 2 Remove the appendix which is still contaminating the peritoneal cavity
- 3 Be particularly attentive to the abdominal complaints of the extremes of age
- 4 Do not disturb a process of localization already successfully established. Do not disturb it by removing an appendix embedded in a mass of recently agglutinated intra abdominal viscera
- 5 Do not fail to relieve an abscess under pressure which is showing signs of spreading
- 6 Do not contaminate the peritoneal cavity by crossing the peritoneum to drain an abscess cavity
- 7 Remember that the micro organisms which are factors in appendiceal perforations are multiple, varied and have many peculiar qualities. One of the most dangerous of these qualities is the tendency for these organisms to develop symbiotic anaerobic growths which may cause extensive tissue sloughs. Free drainage is best accomplished by the use of the McBurney.

Arthur) incision when possible, which in the presence of gross abdominal wall contamination can be left open superficial to the peritoneum

8 Support the ill patient with fluids sulfonamides oxygen blood and plasma

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INTESTINAL OBSTRUCTION

HUGH M KENNA MD FACS

DESPITE the improvement resulting from the modern scientific treatment now generally used in the management of acute intestinal obstruction this condition nevertheless remains a serious problem confronting the medical profession

SYMPTOMS

1 *Pain*—As in acute appendicitis in which I have always stressed the importance of the character time of onset and location of pain these characteristics of pain may be stressed in the onset of intestinal obstruction The pain is cramplike in character gradually increasing in severity Its eventual severity will depend upon whether the obstruction is of the simple or strangulated obstructive type as mesenteric thrombosis Once it has reached its peak it remains constant until the segment of bowel involved becomes gangrenous

2 *Vomiting*—Vomiting may be late or early following the onset of pain depending on the location and character of the obstruction For example if the obstruction is located in the left lower colon with a competent ileocecal valve vomiting does not take place until the fluid and gas are forced back into the ileum I wish to call attention to the difference between fecal and intestinal vomiting The former is not seen frequently and it is obvious that not until the ileocecal valve has become entirely incompetent will fecal vomiting occur This will be several hours after the ileocecal valve has lost its control

3 *Distention*—This symptom may come so late that the diagnosis is made and the patient operated upon before distention is an important symptom The abdominal wall may remain soft and without pain or rigidity In the strangulation obstructive type with serum or blood passing into the peritoneal cavity distention and pain occur early

DIAGNOSIS

Early in my medical education Dr John B Murphy taught me that the intelligent use of the *stethoscope* gave much valuable information in intestinal obstruction

The *x ray* may be of importance if employed with the patient in both the recumbent position and if possible the upright position noting the gas above the fluid level as described by Christopher. *X ray* following a *barium enema* may be of importance. As noted in one of the cases presented in this clinic, barium should not be administered by mouth in cases of possible intestinal obstruction.

The *laboratory findings* may not be of great importance unless the degree of dehydration requires full consideration. The leukocyte count is of value when correlated with the symptoms. In dehydration the urine naturally will need watching. Only in unusual cases will the blood chemistry be of any importance. Other than in cases of much vomiting and dehydration the blood chlorides will be low.

Finally, as in all abdominal diseases a detailed *history* and *physical examination* are imperative. Many times a vaginal or rectal examination will make the diagnosis certain.

MANAGEMENT

The factors responsible for cutting down the mortality rate may be grouped under the following headings:

- 1 Early recognition of the condition and immediate hospitalization
- 2 The institution of medical treatment including
 - (a) Proper medical supportive treatment
 - (b) The suction method of decompression of the intestinal tract
 - (c) Proper management of intravenous medication based upon the results of blood chemistry
- 3 Prompt surgical intervention when further attempts with medical management no longer appear logical
 - (a) Personally I am a strong advocate of stage operations in many of these cases

A brief review of some of the principles in the treatment of bowel obstruction that have been established since the early part of this century might be of interest at this point. In 1909 I published a report on the employment of high enterostomy in two cases of acute bowel obstruction. The experience gained with these patients led me to some later experimentation on dogs which was subsequently reported. In 1910 Victor Bonney published a paper on high enterostomy in bowel obstruction from the Middlesex Hospital in England. I read a paper on

this subject before the Canadian Medical Society in 1910 and a good many years after the publication of this paper Professor L W Archibald of Montreal expressed great interest in the surgical treatment of acute intestinal obstruction by high enterostomy based upon his experience

Empirically we used a large amount of normal salt solution in the treatment of the two patients under discussion particularly through the newly formed stoma in the small intestine During this period I discussed the general problem from a physiologic point of view with Professor A J Carlson of the University of Chicago who gave me some excellent advice In a discussion of the principle laid down in my reports on intestinal obstruction before the American Medical Association meeting in New Orleans in the early twenties Professor Carlson made the suggestion that in his opinion the same results as obtained from high enterostomies could be accomplished by introducing a duodenal tube into the stomach and duodenum This statement is not made to take credit in any way from the originators of the principle of decompression by suction but rather to show the evolution in the treatment of acute intestinal obstruction through the period of surgical intervention which in my opinion established the basis for decompression of the intestinal tract by the later Wangensteen suction method

PRESENTATION OF CASES

We have for presentation a group of cases representing different types of intestinal obstruction and instructive points in differential diagnosis

Case I Low Grade Bowel Obstruction Following a Former Operation for Nonenterogenous Cyst of the Colon

A student nurse aged nineteen years was referred from the Medical Service on November 28 1941 with a history of attacks of pain in the right lower abdomen over a period of one year The attacks occurred on an average of twice a month sometimes lasting one or two days but not associated with nausea or vomiting The acute attack came on twenty four hours prior to admission Constipation had been present for two days pain followed by nausea and vomiting began at noon increased in severity for about four hours and then gradually subsided The next morning the patient was fairly comfortable The leukocyte count which had been normal the night before had increased to 11 800 and she presented rather characteristic symptoms of an attack of acute appendicitis Immediate surgery was advised

Under ethylene anesthesia a right rectus border incision was made and on opening the abdomen considerable fluid clear to straw color in appearance, came into view. Serosal hemorrhagic spots were noted over part of the cecum and a dark gangrenous looking mass was found which resembled a strangulated portion of the bowel. Because of the clinical history however an ovarian cyst with a twisted pedicle was suspected. In delivering

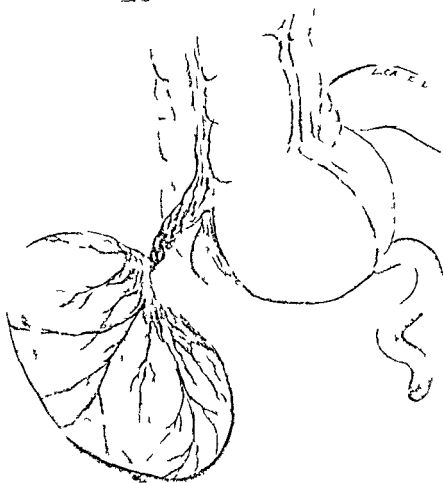


Fig 26—Twisted pedunculated cyst of the colon of nonenterogenous origin

the cecum into the wound, a twisted pedunculated cyst was found (Fig 26) attached to the cecum on the anterior and external surface and lateral to the longitudinal striae running down to the base of the appendix. The pedicle was untwisted and the gangrenous appearance changed to a reddish color. The cyst and pedicle were removed after a photograph had been made in situ showing the relative position of the cyst cecum

ileum passing into the ileocecal valve and the appendix. The appendix was pathologic and was removed in the usual manner.

The pedicle of the cyst was of hard consistency just proximal to the twisted end. Between this point and the wall of the cecum the tissue had the appearance of a diverticulum of the bowel. The stump did not appear to have a lumen or any tissue resembling the wall of the intestine. The histologic report was as follows:

Gross—This specimen is an oval cyst 4.5 by 3 by 1.5 cm attached to a pedicle 3 cm in length, narrow near the cyst and broader near the cut end. The surface of the cyst is smooth, the wall thin. It contains clear straw-colored fluid in a cavity which is incompletely divided into compartments by thin fibrous septa. The lining is smooth. The pedicle is made up of fatty and fibrous tissue and contains no channel that communicates with the cavity of the cyst. The fluid from the cyst contains small round and cuboid granular epithelial cells.

Microscopic—Sections through the pedicle reveal fibrous and fatty tissues with dilated engorged blood vessels. It contains no epithelial tissue. The wall of the cyst contains innumerable tiny cysts with flat endothelial lining. Scattered hemorrhages are present in the wall near the lining.

The patient's convalescence was uneventful. She was able to resume her nursing duties and had no more trouble until September 6, 1943, when she entered the hospital with a history of pain for three weeks, some distention in the lower part of the abdomen and of having vomited once. The pain has persisted rather constantly and had increased in intensity up to a few days ago.

On physical examination the patient had much pain, especially on pressure in the lower right quadrant at the lower angle of the old wound. There was a definite indurated mass in this region which in my opinion was due to an adherent bowel, although the x-ray reports following a barium enema apparently showed a normal appearance of the large intestine in this location.

Because of the belief that this was a low grade type of obstruction that could be carefully observed and because of a history of a similar condition in the patient's sister, which proved to be a malignant growth, we did not operate upon the patient immediately. She was seen by Dr. L. E. Hines of the Medical Department, who suggested that because of the history of urinary frequency the case be studied in detail from the genito-

urinary point of view. A ureteral catheterization was done by Dr. Charles M. McKenna. He noted that the right ureter was not in the normal position.

This case is presented as the type in which the patient is not acutely ill and may very logically be cared for without danger to herself because she is resident in the hospital. In the event of an acute attack she could be operated upon without delay. This plan of management is not to be taken as a contradiction to my previous statements concerning early operation in acute bowel obstruction. There was a possibility that the patient might improve sufficiently so that she would not have to submit to an abdominal operation for the relief of this partial obstruction.

The patient continued to have pain, however, which increased in character, and additional symptoms of intestinal obstruction developed. She was therefore sent to operation on October 12, 1943, which was done under ethylene gas anesthesia.

An incision was made over the outer border of the right rectus muscle just mesial to the old scar of the first operation. On opening the peritoneal cavity in a part that was free from adhesions a mass could be felt lateral to the incision to which the small bowel as well as the omentum were markedly adherent. After a careful dissection two cysts were exposed, the lower one the size of a small hen's egg and the other $\frac{1}{2}$ inch above it the size of a pullet's egg. These two cysts were adherent laterally to the ileum covering $\frac{3}{4}$ of the circumference. The cysts appeared to have origin in the lower part of the omentum. They were carefully dissected away from the small intestine making certain that the entire cyst wall came away although they ruptured in the procedure and a clear fluid escaped. A number of small grayish white glands the size of buckshot were situated in the omentum and adherent to the cysts. The lower end of the omentum was resected completely removing the glands and cysts. These tissues were sent to the laboratory for special examination, the report of which is included.

The uterus and both ovaries were examined carefully and appeared entirely normal. No other abnormal condition was noted in the abdominal cavity. Because of the unavoidable rupture of the thin cyst wall sulfathiazole powder was placed in the peritoneal cavity and firm closure of the abdomen was made.

The histologic report follows

Clinical Diagnosis—Cyst of the mesentery of bowel

Gross—The specimen consists of two cysts attached by a narrow strand of fibrous tissue the larger one 3.5 by 3 by 2 cm and smaller one 2.5 by 1.5 by 1 cm. The wall of the larger one is quite thick, and in the smaller one the lining is trabeculated and hemorrhagic beneath and gray in color. At the pole of the larger cyst is a nodular firm mass 1 cm in diameter.

Microscopic—The yellow nodules are sheets of large oval and polyhedral cells with clear cytoplasm and small nuclei. There are diffusely scattered cysts in the groups of cells. The walls of the cysts contain many islands of similar character. Numerous well defined cysts are also present in the wall of the large cyst. The cysts show no well defined epithelial lining.

Pathological Diagnosis—Endothelioma of peritoneum with cystic changes

Referring again to the first operation I find no mention of a nonenterogenous cyst of the colon in an extensive review of the literature. Ladd¹ suggests the term duplication of the alimentary tract to cover various malformations listed as mesenteric cyst, enteric cyst, enterogenous cyst, diverticulum and so forth but his review does not include a case of the type presented here. Waller, Coburn and Pendleton report a retroperitoneal cyst simulating appendicitis which upon removal weighed 1482 gm, contained clear colorless fluid and upon section showed a single layer of columnar epithelium.

I am indebted to Dr. Raymond C. Pogge for the careful study and review of the literature in this case.

Case II Obstruction of the Ascending Colon Due to Adhesions

This patient, Sister C. D., a student nurse, had a sudden onset of right lumbar pain radiating to the lower right quadrant and right groin. It was associated with slight urgency and frequency of urination. There was no nausea or vomiting. She had had previous attacks of right lower quadrant pain lasting from four to five hours without nausea or vomiting. The only other significant point in the history was constipation and the presence of gas and flatulence following a hemorrhoidectomy two years previously.

On examination by the resident the abdomen was flat with boardlike rigidity and the bowel sounds were increased. He made a tentative diagnosis of right renal calculus or a perforated viscus.

Because of this diagnosis Dr. Charles M. McKenna was asked to see the patient. On cystoscopic examination and plain x-ray films

there was no evidence of renal or ureteral calculus I was then called to see the patient and because of the acute colic and the boardlike rigidity of the abdomen it was decided to open the abdomen

At laparotomy the appendix showed chronic inflammation and adhesions around its base. The colon was moderately distended at the cecum and continued to become more distended as it was followed distally. The distention was most marked in the sigmoid which had an extremely long mesocolon and continued into the cul de sac. No mass could be felt in this region, although the patient was extremely tender on rectal examination before operation. The uterus and adnexa appeared free. The gallbladder appeared normal. There was an area of scar tissue approximately in the midportion of the ascending colon that tended to constrict the colon at this point. The adhesions extended across the ascending colon the width of four fingers in the middle of which was an old cicatrix. The appendix was drawn out through the lower angle as a preliminary step in appendicostomy. A firm closure of the wound was made. The following morning an appendicostomy was performed. A small catheter was introduced into the lumen and secured with fine catgut around the appendix.

It is significant to point out that in all cases of obstruction more stress should be placed upon the location of the distended bowel and the futility of searching the abdomen until the surgeon reaches the lowest point of distention in the bowel. That was particularly true in this case where the large bowel was distended. The scar formation that was found could not be explained. In view of the patient's condition an appendicostomy was performed. The catheter was removed from the lumen of the appendix six days following operation. The tip of the appendix had become gangrenous from the cutting off of the circulation following the appendicostomy and was allowed to slough off. The wound of the appendix healed satisfactorily and the patient made a good recovery.

Case III Partial Obstruction of the Large Bowel by Adhesions Probably Due to Operative Trauma

Mrs P. S. was admitted to the hospital on July 17, 1943, on the service of Dr. Leland Shafer with a history of nausea and vomiting and griping abdominal pain for two days. After a very complete study Dr. Shafer made a diagnosis of partial bowel obstruction

most likely in the region of the splenic flexure but not originating within the intestinal wall. The patient had had laparotomy seventeen years previously but was unable to say what had been done. I was called in consultation.

There was little if any abdominal distention. Peristaltic waves were visible in the umbilical area. The sigmoid was palpable. On rectovaginal examination the cervix was small, hard and slightly nodular, and behind the constricted folds in the upper vagina the body of the uterus was apparently not palpable. It may have been removed in the former operation. The tubes and ovaries were not palpable. There were no tumors or endocervicitis. There were external old hemorrhoidal tags with a spastic sphincter. Posterior to the rectum could be felt individual tumors, some as large as the distal phalanx of the little finger. These appeared at intervals along the course of the rectum. Nothing could be felt inside the rectum as far as the fingers could reach.

A diagnosis of partial intestinal obstruction due to adhesions from the previous pelvic operation was made and operation decided upon. Incision was made on the left side of the old scar running from the symphysis to 2 inches beyond the umbilicus. The abdominal cavity was entered without difficulty. The transverse colon came into view and was quite markedly distended. The distention was followed down to the point in the lower sigmoid. There were numerous adhesions over the descending colon with marked angulation of the lower end of the sigmoid where firm adhesions were formed between the lateral parietal peritoneum and the lateral surface of the sigmoid. These were freed for a distance of approximately $2\frac{1}{2}$ inches and the cut surface carefully covered over with peritoneum both on the lateral wall of the sigmoid and the visceral surface of the abdominal wall. The entire intestinal tract was carefully examined and no further pathologic change was found.

The adhesions present in this case may have been due to trauma to the delicate serosa of the bowel at the first operation. Such trauma may result from the use of harsh sponges which are not properly moistened or from other manipulation.

Case IV Acute Intestinal Obstruction Due to Carcinoma Dangers in Barium by Mouth

This case is one of acute intestinal obstruction brought about by carcinoma of the ascending colon near the hepatic flexure. During the process of examination barium by mouth was used so that when I was called to see the patient four days later he had a severe

acute obstruction and it was necessary to decompress the bowel immediately by a single stage operation. When the peritoneum was opened there was great distention of the small intestine which was filled with barium. It was decided to decompress the small intestine in the ileum a short distance above the ileocecal valve rather than in the cecum. The patient went on to recovery although it took a long period of time to remove the barium.

After the intestinal tract had been entirely cleared of barium the patient was given a barium enema and a diagnosis was made of carcinoma of the colon just proximal to the hepatic flexure. The patient was operated upon in two stages according to the Mikulicz principle and the growth removed. During the operation it was noted that owing to the amount of colon removed the second stage of the Mikulicz operation might not be successful. The clamps however were put in place and in a short time it seemed inadvisable to attempt to bring the colon together by this principle. Therefore in the second operation the ileum was cut off proximal to the ileostomy opening and transplanted into the transverse colon. The patient continued to have bowel movements per rectum although for a time they were irregular and too frequent. When this condition improved the ileostomy opening including the cecum and ascending colon to the site of the original Mikulicz operation was removed. The patient went on to a satisfactory recovery and was discharged from the hospital. He has reported to the office from time to time and at his last visit one week ago he appeared to be in a perfectly healthy condition. As might be expected from the extent of the operation in the abdominal wall there is a beginning hernia in the upper right quadrant. This hernia can be well controlled by the use of a surgical belt until such a time as the patient may submit to operation for its repair.

This case is reported for two reasons. First it brings out the necessity of using great caution in employing barium by mouth for diagnostic purposes where there is a possibility of intestinal obstruction. This is the second instance in which I have been called upon to operate after barium blocked the intestinal tract. Secondly this case illustrates what can be done in stage operations in acute intestinal obstruction.

Case V Intestinal Obstruction Caused by a Gallstone

This patient Mrs. P. S. was admitted to the hospital with a history of severe upper abdominal pain, nausea and vomiting. A diag-

nosis of intestinal obstruction was made and she was operated upon. An incision was made to expose the upper abdomen in the mid line. On opening the abdomen distention of the small bowel was noted. The bowel was orientated by locating the ligament of Treitz and then following the bowel in the opposite direction. A hard mass was found at the jejunum and ileum. The bowel was picked up isolated from the rest of the peritoneal cavity and opened by incision. A gallstone was removed. The bowel was closed in a transverse line with regular intestinal suture and over it two rows of Lembert sutures. The entire field was carefully sponged with laparotomy sponges moistened with 0.5 per cent lysol solution. Firm closure of the abdomen was made. The patient went on to a good convalescence.

In acute abdominal conditions in which an attempt is made to remove the obstructing factor it is important to remember that as little manipulation should be carried out as possible. This is rendered relatively easy if the surgeon will just remember that he should immediately search for the collapsed portion of the bowel which always gives him the key to the obstruction. This is much easier than to pull through the distended bowel which causes a great deal of trauma.

Case VI Acute Intestinal Obstruction Due to Scar Tissue about an Old Appendectomy Scar Preliminary Colostomy

Miss A. M. aged sixty years was brought to the hospital on May 6, 1941, suffering from a high grade intestinal obstruction. She was immediately seen by Dr. Allen Hoover who called me in consultation. After a careful examination the patient was immediately given intravenous supportive treatment with milk and molasses enema and a heat cradle was placed over the abdomen.

The history was that the patient had worked in her garden until early afternoon of May 5 when she developed sudden pain in the abdomen, distention and constipation. The symptoms continued until admission to the hospital allayed only to a degree by morphine sulfate given before entrance. There was nothing of importance in her history except an operation for appendicitis thirty-one years before without complications or sequelae.

There was no decrease in the distention and the obstruction was becoming more severe so at 7:45 P.M. May 6 the patient was taken to the operating room and under ethylene anesthesia a colostomy was performed just above the cecum. The operation was in two stages and a catheter was inserted the following morning. Except for an exacerbation of a previously existing cardiovascular condition on the third day the recovery was uneventful and the

patient was discharged on June 22 1941 with a small colostomy opening. She reported at the office for dressings and the colostomy continued to close the granulations being occasionally treated with silver nitrate stick. She had such a strong aversion to entering the hospital that she refused to return for closure of the colostomy opening.

On May 7 1943 the patient was brought to the hospital as an emergency case. She had vomited dark material several times that day and had pain radiating to the back and up to the shoulder. She was given intravenous medication and the Wangenstein suction pump was introduced. The heat cradle was applied and $\frac{1}{4}$ grain of morphine sulfate was given to quiet her.

In the treatment of an old sinus at the site of a former colostomy breakdown the sinus had acted as an escape valve and prevented an obstruction. I was of the opinion that after the sinus had diminished in size and the skin had cleared a subsequent operation might be done. The sinus closed under treatment and the skin was in good condition so on May 20 1943 an operation was performed to repair the colostomy. The hard cartilaginous fibrous material around the stoma was dissected out and the sinus invaginated with a purse string suture. A Lembert suture was placed over it. Sulfathiazole was dusted into the wound and a firm closure of the skin made.

The patient convalesced satisfactorily. The bowel movements were carefully watched to make sure that no abdominal distention developed. By June 23 the skin over the site of the colostomy had healed. It was decided to perform an operation to free the scar tissue about the appendectomy scar and to repair the postincisional hernia.

The operation was performed under local anesthesia using 1 per cent novocain and three drops of adrenalin to the ounce because the condition of the patient was not good. The old hernia was carefully dissected out and the bleeding points arrested. The hernial content was returned to the abdomen which was held by keeping the patient in the Trendelenburg position and a modified Mayo trap door operation was performed. Sulfathiazole was used in the wound. A firm closure of the abdominal wound was made and the patient's condition was satisfactory at the close of the operation.

The patient made a good recovery and was discharged from the hospital on July 29. She was instructed to wear a surgical belt because it had been impossible because of her poor physical condition to build up the abdominal wall as firmly as desired.

Case VII Acute Intestinal Obstruction in Aged Man Due to Adhesions
Preliminary Colostomy

Mr J J aged seventy three years was admitted to the hospital on September 18 1941 with pain in the right lower quadrant distention vomiting decrease in size of the stool and almost complete obstruction for four days. On examination there was much distention with pain and tenderness on palpation of the right lower quadrant. Active peristalsis could be made out through the abdominal wall. He had had two previous abdominal operations. A diagnosis of acute intestinal obstruction was made. Owing to the patient's age and physical condition it was decided to perform a preliminary colostomy.

After the adhesions around the cecum had been broken up the large bowel was drawn through the abdominal wall and secured by eight interrupted catgut sutures to the peritoneum and fascia then securely and tightly attached to the skin. This line of sutures made very intimate connection between the serosa of the bowel and the skin which tended as nearly as possible to seal these layers hermetically thus preventing any accidental leaking around the stoma with escape of intestinal contents into the peritoneal cavity. Owing to the amount of distention and the patient's condition it was deemed advisable to decompress the bowel immediately. This was done by means of cautery after the purse string suture had been put in place. Immediately upon opening the bowel a fenestrated large catheter was introduced into the bowel and a suture drawn down after which another purse string suture was placed in the bowel 1 cm. lower down and the tube invaginated and secured in this position using a special knot on the catheter in order to prevent any pull. At the point of the last purse string suture before opening the bowel strips of vaseline gauze had been tied securely around the bowel at the junction with the skin and serosa.

The patient made a good recovery and was discharged October 4. The colostomy was allowed to continue until it was of small size the opening being no larger than a quarter and the surrounding skin well healed so that there was no suppurating or infected tissue. He then returned for closure of the colostomy. On November 14 1941 under local anesthesia a very careful dissection was made around the stoma in order not to leave any epithelial tissue and yet not destroy the serosal and mucosal edges of the wound. A closure of the intestine was made with interrupted chromic catgut and over this a row

of continuous Lembert sutures was inserted which turned in the first row of sutures perfectly, and then a mattress suture was placed in the immediate fascia to relieve pressure on these sutures. After this the wound was approximated. The patient made a good recovery and was discharged on the fourteenth day.

CONCLUSIONS

In all patients suspected of having intestinal obstruction one should follow much the same rules as in acute appendicitis.

- 1 Immediate admission to the hospital is demanded.
- 2 If the patient's physical condition warrants a complete physical examination should be made and a careful history taken.
- 3 Immediate therapeutic treatment is indicated.
- 4 Complete laboratory and x-ray examinations are essential.
- 5 The early institution of surgery is advisable when therapeutic management does not appear to give results.
- 6 In a percentage of cases stage operations will lower the mortality rate.

SUMMARY

In my opinion there will be a marked reduction in postoperative intestinal obstruction when the surgical profession adopts a greater degree of refinement in handling open wounds. My convictions in this matter were formed in bone surgery where I have always carried out a strict Lister technique and as a result infection from trauma has been negligible. Because of this experience I have always taught the principle of being meticulous in handling tissues particularly in abdominal operations. Careful and detailed presurgical examination will make it unnecessary to make many exploratory examinations.

The proper use of well saturated moist abdominal sponges carefully placed at the beginning of the operation is important. I do not use dry sponges in any operation. In the introduction of well moistened laparotomy sponges (and I use no others in abdominal surgery) great care is used not to *drag* the sponge into the wound but rather have the surgical nurse hold the sponge up as it is placed in the abdominal cavity thereby lessening the degree of trauma to the sensitive serosal layer of the abdominal viscera. The minutest insult to this structure forming a potential adhesion which may and often does lead to a subsequent intestinal obstruction.

A very important factor in preventing abdominal adhesions

results from a well administered anesthetic that produces complete relaxation so that pressure in packing in laparotomy sponges is unnecessary

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POLYPOSIS OF THE COLON*

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POLYPS of the colon have received considerable attention in the surgical literature in recent years because of the increasingly successful operative attack on carcinoma of the colon and rectum. Surgeons especially interested in this field have directed their activities towards the earlier diagnosis of malignant lesions of the large bowel and as a corollary towards the definition of precancerous conditions. Polyposis of the colon has been shown to have a direct relationship to malignant neoplasms although in point of incidence this relationship is numerically small and not necessarily one of cause and effect.

It is difficult to assess the true significance of the presence of one or more polyps in the large bowel in any given patient. Some authors have expressed the opinion that many or most cancers of the colon or rectum have had their origin in pre-existing polyps. This premise is almost impossible to prove since the majority of specimens of cancer of the colon show a lesion advanced far enough to have obliterated all traces of a pre-existing polyp when they are examined. There are, of course, many instances of malignant change in a portion of an otherwise benign polyp, but such specimens constitute only inferential evidence and prove nothing beyond the fact of their own existence. The question can best be discussed from the standpoints of incidence of polyposis of the colon and of definition as to what constitutes a polyp and what types of polyps are potentially malignant.

INCIDENCE

The best evidence as to actual incidence of polyposis of the colon comes from reviews of large autopsy series on relatively unselected patients. At least three such reviews are available. Lawrence¹ reporting on a series of 7000 autopsies from Cook County Hospital notes the occurrence of polyps as 2.37 per cent in the colon and 0.42 per cent in the rectum. Susman

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reporting on 1110 autopsies notes an incidence of polyps of the colon of 6 per cent. Lawrence explains this discrepancy by the fact that his series contained many more necropsies on children in whom polyps are much less frequent than adults. This latter fact is well borne out by the figures of Feyrter³ who in 1929 reported on the incidence of polyposis in 1800 autopsies. He found 1017 polypoid lesions in 1100 colons examined. Of these lesions 767 were minute excrescences of the mucosa whose classification as true neoplasms is very doubtful. In this series there was no instance of multiple or diffuse polyposis. Most interesting in the break down of his figures is the finding that in the age group 45-54 one third had lesions of the colon, 55-64 one half had lesions, 65-74 two thirds had lesions and in the group 75-87 three fourths of all colons examined showed pathologic changes which he classed as polyposis. In his whole series there were fifteen instances in which cancer of the colon caused death and four others in which carcinoma of this organ was an incidental finding. Feyrter's review certainly points out the frequency of polypoid conditions in the colon yet it shows a numerically small incidence of accompanying carcinoma. The variations in these three autopsy series are probably explainable largely on the basis of definition of what is and what is not a polyp.

Inconclusive as the autopsy series are, the evaluation of clinical data is even more confusing. Buie⁴ from the Mayo Clinic has reported that he found one or more polyps in one out of every thirty-five patients proctoscoped in a large series of cases. Swinton and Warren from the Lahey Clinic report a series of 156 benign and malignant polyps in which 70 per cent were visible through the sigmoidoscope and in which 35 per cent had more than one polyp. In this latter report the authors state that 14 per cent of 877 cancers of the colon can be shown to have arisen in benign polyps. C. W. Mayo has reported that in 334 necropsies on patients dying of primary carcinoma of the colon or rectum 34 per cent had polyps of the large bowel in addition to the fatal lesion. Westhues⁷ studied 100 resected specimens of rectal cancer and was able to demonstrate polypoid change in 45 per cent and in his opinion 15 per cent of the malignant lesions arose from previously benign polyps. David⁸ was able to show accompanying polyps in 13 per cent of his own group of carcinomas of the large bowel. None of these varying percentage figures is contradictory but they only prove a rela-

relationship between benign polyps and carcinoma of the colon. They do not define that relationship. In the clinical reports it is natural that more polyps should be found in the rectum and rectosigmoid because this area of the bowel is the most accessible in the living human and small polyps are much more easily demonstrated by direct vision than by roentgen methods.

CLINICAL TYPES

Polyps of the colon are usually defined as pedunculated or sessile tumors of the mucosa whose essential tumor component is glandular epithelium, the supporting structure being composed of fibrous tissue and its vascular supply. This excludes tumors such as fibromas, hemangiomas, lipomas, and angeliomas whose epithelial component is simply the normal mucosal surface overlying the tumor. True colonic polyps are seen generally in three classes of patients.

The first group comprises those tumors supposedly arising on an inflammatory or irritative basis usually associated with ulcerative colitis, amebic dysentery, chronic bacillary, or other forms of diarrhea. It is the present day conception that most of such lesions are fictitious, being folds due to transient lymphoid hyperplasia, scarring, edema, or other causes. A few true benign neoplastic lesions do arise on such a background, but they are quite rare and are an unimportant part of polyposis as usually encountered.

The second group is composed of those patients with familial multiple polyposis of the colon. This is an uncommon but serious disease in which the entire colon may be occupied by multiple polyps which may be so numerous as practically to replace the normal mucosa with myriads of minute to medium sized adenomas (Fig. 27). This disease tends to occur early in life, symptoms sometimes beginning in childhood, and it has a distinct tendency to occur in many members of the same family over a period of generations. Numerous case histories have been recorded of such families, and there is no need to go into details here over their published accounts. The seriousness of this disease lies in the almost invariable supervention of carcinoma of the colon at an early age. Many cases have been reported with multiple cancers of the large bowel arising on the basis of diffuse polyposis or adenomatosis of the colon. In this group the eventual appearance of cancer superimposed on the polyposis is so probable that radical treatment should be considered in all cases when diagnosed early.

The third and most common clinical type of polyposis of the colon is that in which single or occasionally several polyps are encountered on routine examination of persons in the older age groups with symptoms referable to the lower bowel. Polyps by themselves do not ordinarily produce specific symptoms and are usually found only when a complete diagnostic study is made for bleeding or other symptoms referable to the colon.



Fig. 27.—Roentgenogram of diffuse polyposis of colon in infant.

These polyps appear as small single lesions usually from 2 or 3 to 15 mm. in size. They may be solitary or present as scattered foci or clusters of polyps. Naturally most of such lesions are found by proctoscopy and clinical reports indicate that a majority occur in the rectum and rectosigmoid. This may be an artificial picture of their distribution as such small lesions elsewhere in the colon are not easily demonstrated by roentgen methods. This type of polyp might be classified as incidental.

polyps and though less commonly than is described above may occur as large solitary lesions up to 4 or 5 cm in diameter. These lesions frequently will show malignant areas in the epithelium and of course must be treated as carcinoma which they are. Completely benign polyps can reach the size of an adult fist and cause large bowel obstruction but this is a very uncommon occurrence. Such lesions are not pedunculated but are composed of frondlike strands and tufts of hyperplastic epithelium growing out from a wide base.

PATHOLOGY

The gross and microscopic anatomy of polyps of the colon may vary considerably, and any of the clinical types mentioned above may show combinations of the few basic variations of histopathology. Epithelial change is the essential pathologic change in true polyps and it may vary from an almost entirely normal picture to one so hyperplastic and atypical that differentiation between benignity and preinvasive cancer may be impossible. Several classifications of polyps on a histopathological basis have been proposed but in general the shading off into degrees of differentiation is so insensible that classification is meaningless.

At one end of the scale a polyp may be composed entirely of submucosal tissue covered by apparently normal epithelium. Some of these polyps with normal appearing epithelial cells may show a preponderance of mucus secreting or goblet cells and in some the tubules may be enlarged as compared with the normal. In others the epithelial cords show branching effects with treelike cords of submucosa covered with apparently normal epithelium. Some polyps exhibit architectural hyperplasia in the sense that the epithelium is increased in thickness with multiple folds and cystlike cavities while the individual epithelial cells composing such a tumor appear completely normal when studied by the usual staining and microscopic methods. Cytologic change is most commonly present in this last type of polyp presenting usually as islands of obviously atypical epithelium whose cells stain more darkly and with loss in normal cell relationship and nuclear polarity. Such a tumor is probably the dangerous type from the standpoint of being a precancerous lesion. From this form of polyp the progression towards malignancy proceeds with polyps composed of papillary epithelial overgrowth the cells of which are distinctly atypical and in some areas may be classified as carcinoma in situ or show

invasive tendencies. An orderly procession of increasing differentiation toward malignancy in colon polyps cannot be demonstrated, however, as in some cases of multiple polyposis, polyps of all types may be present with carcinoma appearing in small areas of the most nearly normal epithelium. Such situations tend to give the impression that polyps are side effects or incomplete responses to an undetermined carcinogenic factor rather than necessarily precancerous lesions in themselves.

The main problem in the microscopic pathology of these lesions is first the inadequacy of the usual biopsy and secondly the interpretation of the borderline pictures. The pathologist's diagnosis is limited by the material presented to him and it is far better for the surgeon to remove an entire polyp than to cut away a small portion of the lesion for biopsy purposes. Many early cancers will be found in this way that might otherwise be missed until recurrence or further growth takes place. The problem of the borderline histology is occasionally a difficult decision. The author is of the opinion that a valid diagnosis can be made of carcinoma in situ or pre-invasive cancer and that demonstrable invasion is not always an essential criterion of malignancy. If however the pathologist essays to make such diagnoses it must be on the basis of rigidly enforced criteria. The easy way out is always to call a doubtful lesion malignant but this can do much harm.

SYMPTOMS

There are no specific symptoms that point to polyposis in any given patient. Rather polyps can reproduce any of the reactions of colonic or rectal irritation and the average case history will show that the two most common complaints of such patients are either *bleeding* or *chronic diarrhea* or both. The great majority of patients will present the foregoing complaints and only a complete diagnostic work up will show the underlying lesion. All too often physicians tend to consider rectal bleeding as due to hemorrhoids and diarrhea as due to colitis and probably in most cases an inadequate examination is given a patient before treatment is instituted. Unfortunately most adults do have demonstrable dilatations of the inferior hemorrhoidal veins and such minor anatomic variations constitute a simple explanation for rectal bleeding without further search. Many diagnoses of polyposis are missed or delayed for this reason.

Polyps of the colon ordinarily produce somewhat more *mucus in the stool* than is usual and one symptom that is some

what characteristic of the large solitary low lying polyp is a marked morning *urgency to defecate*, the bowel movement containing much mucus Binkley⁹ has noted this to be a fairly constant finding but these lesions are rare except in a clinic with a large rectal tumor service Other bizarre effects of the presence of polyps are rare instances of intestinal obstruction due to large solitary polyps in the descending colon or rectosigmoid and occasional occurrences of intussusception due to peristaltic pull on a pedunculated adenoma

DIAGNOSIS

Since most polyps of the colon do not produce any pathognomonic symptoms their diagnosis depends entirely on complete examination of the rectum and large bowel in those patients who present complaints indicative of a chronic lesion It cannot be emphasized too strongly that any patient who presents complaints referable to the lower bowel particularly bleeding should have a *digital anoscopic* and *sigmoidoscopic examination* as the minimum essential diagnostic maneuver

As stated above the frequent presence of hemorrhoids should not be considered an adequate explanation of rectal bleeding until other causes are ruled out Bleeding from above the anal ring or intermittent mucous diarrhea or the presence of one or more polyps found by proctoscopy are indications for further examination by barium enema Any one of the preceding conditions should be followed by *roentgen examination*, and if polyps are demonstrable through the sigmoidoscope the barium enema should be followed by postevacuation films and then by air insufflation and double contrast films to demonstrate the presence or absence of polyps above the area of colon visualized through the sigmoidoscope This is an essential part of the diagnosis because these lesions tend so often to be multiple and distributed throughout the colon When polyps are suspected the barium enema is not usually sufficient to demonstrate them particularly if they are small and the postevacuation and double contrast films must be made

A very important part of these examinations is the *absolute cleanliness of the bowel*, as small polyps can easily be hidden from view by particles of fecal material adherent to the mucosa Such fecal material may also simulate polyps and be confusing Routine preparation usually consists of an ounce of castor oil the night before the examination and a thorough

cleansing enema the morning of the examination. The proctoscopic examination should precede the roentgen examination as the field of vision is clear of barium particles the cleanliness of the bowel can be determined and the patient further prepared if necessary.

The appearance of polyps seen through the sigmoidoscope is quite characteristic and there is no difficulty in detecting them except that the presence of carcinoma usually depends on microscopic examination. The polyps appear as excrescences of round or mulberry shape either the same color or a little darker than the normal mucosa. They may form clusters particularly as groups of small lesions less than 1 cm. in size. Most polyps are less than 1 cm. in size and the small ones measuring only a few millimeters may easily be hidden behind mucosal folds.

TREATMENT

Treatment of polyposis of the colon is entirely surgical and comprises three types of procedures: local destruction through the proctoscope, colotomy and removal of the polyps and colectomy either segmental, subtotal or total. In patients with multiple polyposis combinations of these methods may be utilized. The indications for the use of each are fairly clear cut but there are a few situations in which decision is difficult.

Local treatment of polyps through the proctoscope should preferably consist of complete removal of the tumors with the electrocautery snare. Fulguration of these lesions is to be condemned particularly if ulceration is present because no tissue is removed in this manner for microscopic assay. Of course only the pedunculated tumors are best suited to snare removal but the flat sessile polyp can be largely removed in this manner leaving the base to be destroyed by local fulguration. The ordinary sigmoidoscope can be used for this purpose but a better instrument is the totally insulated proctoscope made of hard rubber or a black and nonreflecting plastic. Anesthesia should be used for such a procedure both for the patient's comfort and the operator's ease the latter because reaching a polyp with a snare requires more manipulation than simple visualization of the lesion and anesthesia will allow greater latitude of motion and less operating time. Caudal block can be used for very low lesions but a low spinal or general will be necessary for lesions along the full length of a sigmoidoscope.

There is difference of opinion among surgeons as to the

proper type of treatment for polyps above the peritoneal reflection. All agree that there is some danger in electrocautery removal of these tumors above this level because of the possibility of perforation with resultant peritonitis. Perforations at this point may occur either immediately or sometime later after an interval of twenty-four to seventy-two hours if the whole thickness of the bowel wall has been devitalized by the heat of the cautery. For this reason Cattell and Swinton¹⁰ recommend laparotomy and sigmoidotomy for the removal of polyps of the intraperitoneal colon regardless of whether or not they can be reached by the sigmoidoscope. There is good reason for their attitude but a reasonable middle ground might be defined by limiting the use of the sigmoidoscope and cautery to the smallest lesions at this level.

In all patients in whom surgery of the colon is to be done whether by laparotomy or through the proctoscope it is advisable to have them well prepared by cleansing enema. A non-residue but nourishing diet should be given for forty-eight hours preceding the operation and in those patients in whom there is no danger of obstruction a cathartic such as castor oil should be administered the day or night before the enema and surgery. Especially in patients who are to have laparotomy an intestinal antiseptic such as succinylsulfathiazole should always be given for three days before the operation. This drug is usually given in doses of 0.33 gram per kilogram of body weight per day in divided doses.

Resection of the colon in whole or in part allows a number of variations of procedure in removal of polyps. The surgical procedures are standardized but the problem is choice of the best method for any given situation. Resections of the large bowel are used mainly when the polyps are located above the reach of a sigmoidoscope. When a cluster of polyps or a large solitary lesion is demonstrable and there is reasonable certainty that no other tumors exist *local excision* or *segmental resection* of the bowel can be considered with either primary anastomosis or secondary closure of a colostomy. If local excision is done the base of the polyp and the entire thickness of the underlying bowel wall should be removed as simple removal of the polyp from the mucosa is not an adequate procedure in those regions of the colon which cannot be easily reinspected through the proctoscope. Even with small polyps the presence of cancer is a constant hazard and cannot be ruled out even with biopsy.

One of the most difficult decisions in the handling of polyps is what to do with the patient from whom a polyp has been removed which on microscopic examination reveals a small area of tissue which is doubtfully malignant. The decision is most difficult when the lesion is in the rectum because radical surgery for such a lesion entails removal of that segment at least with resultant permanent colostomy. If a rectal lesion is definitely malignant then a radical resection of the Miles type is indicated because the size of the tumor does not control the likelihood of metastases to adjacent nodes.

Subtotal resection of the colon should be done in those patients in the earlier age groups who have multiple polyposis scattered throughout the large bowel when the lesions in the rectum and lower sigmoid are controllable through the sigmoidoscope. In such a patient the eventual occurrence of cancer in the bowel is so probable that such a radical procedure is indicated. Ideally, the polyps in the rectum and rectosigmoid are destroyed by electrocautery and fulguration through the operating sigmoidoscope and then an ileosigmoidostomy is done with resection of the colon down to the point of anastomosis. This procedure may be done in as many stages as seems advisable for a given case depending upon operability. Following this the patient must be checked at regular and frequent intervals by proctoscopy and any new polyps destroyed as they occur. This must be done for the rest of the patient's life for the possibility of cancer is ever present.

Total colectomy is reserved for those patients with such profuse polyposis that control of them in the terminal gut through the sigmoidoscope is impossible. In a few patients with familial diffuse polyposis the mucosa may be totally replaced by the polyps; in such cases it is futile to attempt to clear up such situations locally. The decision as to when to do total colectomy in such patients is difficult and there is no agreement among surgeons. No one wants to condemn a patient to a permanent ileostomy simply to remove a potential carcinoma and most patients will refuse such a recommendation unless they are having enough trouble from diarrhea and bleeding that they are driven to it. Most surgeons wait until symptoms are severe enough or until there is evidence of carcinoma before undertaking such a procedure. At any rate patients with such lesions must be followed very closely if they are not operated upon at once. In general ulceration or bleeding which has progressed

to the point of being present daily, is strongly suggestive of carcinoma, even though the x ray may not reveal the deformity of a malignant tumor. This point alone may be the deciding factor in making the decision to resort to radical treatment.

PRESENTATION OF CASES

CASE I—M E, a Negro woman aged fifty six years was admitted to the Research Hospital November 19, 1938. The patient had had a low grade discomfort in the left lower abdominal quadrant for fourteen months and she had lost 25 pounds in weight in the last year. For the last six months she had had blood in the stools daily. This was fresh red blood and was mixed with mucus usually appearing at the end of each bowel movement. Her past



Fig. 28 (Case I)—Cross section of entire polyp removed from the sigmoid colon by segmental resection. There is definite invasive carcinoma in the tip of the polyp with the remaining tumor being entirely benign.

history was irrelevant except that she had had a supracervical pan hysterectomy for fibroids in 1929.

Physical examination revealed nothing remarkable and she was referred to the Rectal Clinic for proctoscopy and barium enema. A polypoid nodular pedunculated lesion was found at 22 cm and a biopsy showed adenocarcinoma.

The patient was referred to the surgical service and an exploratory operation showed the lesion to be localized and about 3.5 cm

in diameter. As it was situated too low to be exteriorized, and it was thought that complete resection of the rectum was unneces-



Fig 29 (Case I) —H&E photomicrograph of lesion in Figure 8 section taken through junction of benign and malignant epithelium

sary a preliminary colostomy was done through an inguinal stab wound. A few weeks later 8 cm of sigmoid above the reflection

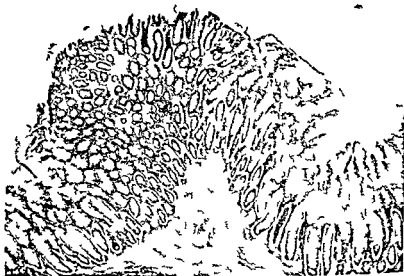


Fig 30 (Case II) —Section of polyp removed from patient with diffuse polypoidosis of the colon. Lesion shows benign polyp with minimal inflammation

was resected and the bowel continuity restored by end to end anastomosis. The colostomy was later closed after complete healing had occurred and the patient has been well since.

The patient was last examined on August 24 1943 at which time there was no evidence of recurrence. The resected specimen showed a pedunculated polyp with adenocarcinoma only at the tip the rest of the lesion presenting only atypical epithelium shading off into normal appearing mucosa at the base (Figs 28 29)

CASE II—C P a white man aged nineteen years was admitted to the Research Hospital October 7 1941. The patient was entirely well until about three years previously when during the summer



FIG. 1 (Case III)—Roentgenogram of large solitary polyp of the upper rectum

he had an attack of severe diarrhea which lasted for eleven days. Since then he had periods of intermittent diarrhea with five or six bowel movements daily lasting for about one week and appearing at intervals every two or three months. Both during attacks and during free intervals there would occasionally be fresh blood in the stools. Patient's family history was entirely irrelevant except that two uncles died of cancer one of the ear and one of the tongue. There were no members of the family with any intestinal trouble.

Physical examination was negative except for moderate tenderness over the left abdominal quadrants. Proctoscopic examination revealed diffuse polypoid change of the mucosa up to 24 cm with no normal mucosa visible. The individual polyps measured up to 3 cm in diameter and biopsies from two of them were reported as adenomatous polyps (Fig 30).

After surgical consultation it was decided to treat the lesion conservatively as it was impossible to destroy the polyps in the rectum and sigmoid by local measures. Colectomy is to be considered if urgent symptoms develop.

CASE III—G. G., a white male aged seventy-five years, was admitted to the Research Hospital July 10, 1940. For the preceding eight months the patient had complained of a chronic diarrhea having from six to eight bowel movements daily. Each movement consisted almost entirely of white mucus. In the last month there had been some infrequent bleeding with defecation. Past and family histories were irrelevant.

Physical examination was not noteworthy except for the finding of a lipoma situated over the left iliac spine. Rectal examination revealed a soft papillary mass 3 to 4 inches in diameter arising from the posterior rectal wall about 3 inches above the anal margin. Biopsy from this mass was reported as benign papillary polyp of the rectum. Barium enema revealed only this nonobstructing filling defect in the rectum (Fig 31).

Under spinal anesthesia the mass was removed by multiple suture ligations of the base which was 2 inches wide and morcellation of the tumor mass was done. This tissue was likewise reported as showing benign papillary polyp of the rectum. This patient has remained well and there was no evidence of recurrence on August 24, 1943.

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DIVERTICULITIS*

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DIVERTICULA of the colon are either congenital or acquired. True congenital diverticula or secondarily acquired diverticula (those due to traction on the bowel wall) are quite rare and of little surgical interest. By common consent in discussing this lesion we refer to the primary acquired multiple diverticula of the colon (usually the sigmoid) in which the diverticula are herniations of the mucous membrane through gaps in the muscularis. The presence of uncomplicated diverticula is referred to as *diverticulosis*. When these sacculations become inflamed the term *diverticulitis* is used. It should be recalled that in the colon the diverticula form a row away from the mesenteric border in two rows immediately to the mesenteric side of the anterior and posterior lateral muscular taenia at which point the blood vessels enter the submucous layer. They are hernias of the mucous membrane through gaps in the muscle coat and in all but the smaller pouches muscle fibers are present only in the region of the neck of the sac.

INCIDENCE AND ETIOLOGY

It is difficult to fix the true incidence of this lesion. Various statistical studies both clinical and necropsy material place the incidence at between 1 and 10 per cent. An average incidence of about 5 per cent in cases examined roentgenologically is usually quoted but this does not necessarily represent the frequency of occurrence in all patients—only in those with sufficient abdominal symptoms to warrant special examination.

Men are more commonly found to have this disease than women in the proportion of about 2 to 1 and all authors are agreed that males are more frequently affected by the complications of the disease than are females. The majority of cases of diverticulitis are seen between the ages of fifty and seventy years the peak age incidence being fifty five to sixty five years.¹

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Acquired diverticula may occur in any portion of the colon or rectum either singly or in very large numbers diffusely throughout its entire length. The sigmoid and descending colon however are more frequently involved than all other parts of the gastro intestinal tract below the stomach combined accounting together for 75 to 80 per cent of colonic diverticula with the sigmoid alone accounting for the vast majority of these.

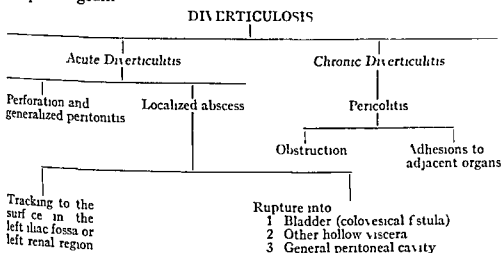
What percentage of patients with diverticula develop diverticulitis? This has been variously estimated from clinical data to be from 12 to 15 per cent (Eggers T L Jones). Of 1300 subjects in whom diverticula were found during routine gastrointestinal examination by Rankin and Brown³ 227 (17 per cent) were considered to have diverticulitis. In the autopsy series of 111 cases reported by the same authors there were sixteen cases (14 per cent) of diverticulitis.

Many theories have been advanced for the etiology of diverticulosis including old age constipation frequent purgation excessive fat or emaciation disturbance of the sympathetic nerves of the colon and an inherent weakness in the structure of the bowel which is usually at the point of exit or entrance of the blood vessels. Most authorities today feel that the diverticula result from high intra intestinal pressure forcing the mucous membrane through the vascular gaps in the muscular coat of the bowel. Edwards feels that there is no evidence to show any congenital predisposition to diverticula or that they are due to degenerative changes in the muscle or to disease of the blood vessels themselves. The pulsion force is probably due to irregular spasm of the bowel musculature maintained over a considerable period of time. Poate⁵ summarizes the factors in etiology thus: "The point of vascular penetration through the musculature of the bowel wall constitutes a point of weakness. General factors influencing the health of the individual or tending toward loss of muscle tone may increase the divarication of muscle fibers at this point. Fatty infiltration may also play a part as may chronic constipation or spastic colitis with either of which gaseous distention is of common occurrence. No single factor can explain the origin of acquired diverticula in the colon and it is much more likely that the process results from a summation of these several factors."

PATHOLOGIC FEATURES

Diverticulitis is always due to retention of fecal contents. It is most common in the sigmoid because (1) diverticulosis is

more common here and (2) the sigmoid contents are solid. When fecal material is squeezed into a fully formed bottle necked diverticulum it cannot readily get out again. As a result of retention the mucous membrane lining the diverticulum becomes inflamed, and an inflammatory reaction involving the sac and the pericolic tissue follows. This of course is associated with further narrowing of the diverticular neck. The stage is then set for a variety of secondary inflammatory changes which have been so well portrayed by Edwards⁴ in the following simple diagram.



SYMPTOMS AND SIGNS

It is commonly agreed that diverticulosis is asymptomatic. With the supervention of inflammation symptoms are produced. In *mild cases* the symptoms are frequently ascribed to an irritable or unstable colon; these symptoms include pain in the left lower quadrant, constipation (sometimes alternating with diarrhea), epigastric distress, flatulence, and nausea. Pain, the foremost and most constant symptom, is usually located in the left lower abdominal quadrant and is of the type usually associated with some degree of obstruction to the lumen of the bowel. It is usually intermittent and is commonly described as cramping or due to gas. The attacks are frequently accompanied by low grade fever, leucocytosis, distention, nausea, and very often symptoms referable to the bladder, such as frequency and dysuria.

In *more severe cases* the clinical picture is that of an acute left sided appendicitis, with tenderness and rigidity in the left iliac fossa. A mass may be felt in somewhat less than half of the cases abdominally or per rectum. Bleeding is an uncommon

symptom The more acute manifestations may be precipitated by strong laxatives dietary indiscretion or trauma

The symptoms vary from this general pattern depending on the development of complications The most dreaded but fortunately the least frequent complication is *acute perforation* into the free peritoneal cavity producing a spreading septic peritonitis (This complication is rare because peridiverticulitis usually serves to wall off the impending rupture by drawing loops of bowel to the sigmoid or fixing the latter to the bladder lateral parietal peritoneum or anterior abdominal wall) The signs and symptoms are those of perforation of any hollow abdominal viscus plus the familiar signs and symptoms of spreading peritonitis This is a dangerous complication with a very high mortality

With *abscess formation* a mass of variable size will usually be palpable The abscess may rupture into an adjacent hollow viscus (with recovery) or it may rupture into the general peritoneal cavity it may also tract to the surface in the left iliac fossa near the anterior superior spine or in the left renal region closely simulating a perinephritic abscess

In *diverticulitis with obstruction* the latter is usually of slow onset rarely becomes absolute and is due to stenosing peridiverticulitis Tumefaction plus obstructive phenomena characterize this phase of diverticulitis It is in this group of patients that it is so frequently difficult sometimes impossible (even at the operating table) to make the differential diagnosis between the inflammatory lesion and carcinoma

Another serious and frequent complication is *fistulous communication between colon and bladder* The passage of fecal material and gas per urethra is pathognomonic of this complication It is well to remember that diverticulitis is the commonest cause of colovesical fistula Higgins⁶ recently studied 382 cases of colovesical fistula and found that ninety two were due to diverticulitis and forty eight were caused by cancer of the sigmoid or rectum

DIAGNOSIS

A carefully elicited history and the symptoms as already noted will usually lead one to the correct diagnosis Supplementary information may be obtained by *x ray examination* of the colon by means of the barium enema and by *sigmoidoscopy* The former will accurately establish the diagnosis by demonstration

of the diverticula as well as the site of the lesion and the extent of involvement. There is characteristically a serrated or picket fence roentgen appearance—one must remember however that there may be a variety of sigmoidoscopic appearances depending on how much of the pouches is filled with the opaque medium.

Sigmoidoscopy may be of value in the diagnosis when the diverticular openings can be seen by direct vision. Other suggestive sigmoidoscopic findings include immobility of the segment being examined, sharp angulation, narrowing of the lumen, mucosal edema, extrarectal mass, and inability to pass the sigmoidoscope the usual distance.

Much has been written about the *differential diagnosis* between diverticulitis (tumefaction) and cancer of the colon. In many cases the differentiation is well nigh impossible even to the most experienced surgeon with the abdomen open. Usually a history of previous attacks of left lower quadrant pain, the finding of a tender palpable mass in the left lower abdomen with fever, leucocytosis, and absence of occult blood in the stools speaks more for diverticulitis. Radiologically, diverticulitis is manifested by varying degrees of spasm and hypermotility of the segment involved; the length of bowel involved is usually longer and unlike the sharp line of demarcation between cancerous and normal bowel, diverticulitis does not terminate abruptly but becomes as it merges into the normal contour of the bowel fusiform or spindle shaped. Schatzler¹⁷ and others have also stressed the facts that in diverticulitis the mucosal folds are preserved, the size of the tumor has a tendency to change, and obstruction is rarely complete.

CONSERVATIVE TREATMENT

Early, mild or uncomplicated diverticulitis may be treated conservatively. Such management consists chiefly of complete bed rest, administration of parenteral fluids to rest the inflamed colon and maintain chemical balance, heat to the abdomen, liquid petrolatum orally, small doses of morphine if pain is a prominent feature, and antispasmodics. Heat is of great value and may be administered in various ways as by hot packs, electric pad, short wave diathermy⁸ and (in women) by the Elliott treatment.⁹ The judicious use of sulfonamide drugs may cut short the period of inflammation. The compounds most widely used at the moment are sulfaguanidine and succinylsulfathiazole. Many enthusiastic reports of the use of these drugs in colon

inflammations have recently been made. For more sustained systemic effects especially with progression of inflammation to involve more of the bowel wall a sulfonamide such as sulfadiazine should be recommended.

As the acute stage subsides food should be given and the diet—low or nonresidue—gradually increased. Some physicians employ warm saline irrigations or warm oil retention enemas but Stone¹⁰ and others advise against this for it seems unwise to them to put fluid under pressure into a sigmoid which is the site of acute inflammation.

SURGICAL TREATMENT

The indications for surgery are the complications of diverticulitis. These include

- 1 Acute perforation and peritonitis
- 2 Chronic perforation—peridiverticular abscess
- 3 Obstruction
- 4 Fistula formation

Acute Perforation

As stated before this is the least frequent but most dreaded complication of diverticulitis. It is an urgent condition demanding immediate operation. As with perforation of other hollow intra abdominal organs the prognosis depends on the interval elapsing between perforation and operation.

The biological disturbances that accompany this complication must be quickly and effectively combated. This includes the intravenous administration of fluids, salt and proteins (plasma, serum, amino acids), the local application of heat and the administration of sedatives. The abdomen may be opened by one of three incisions—median subumbilical, left low paramedian or left oblique muscle splitting. Having exposed the perforated diverticulum there is some difference of opinion as to the method of dealing with the offending lesion. Many surgeons (including Ranl in³, Abell¹¹, Erdman¹, Cornwell¹³) recommend that where possible the perforation should be closed and the peritoneal cavity drained (?). Other equally competent men (Jones¹⁴, Graham¹⁵, Shallow¹⁶) believe that no attempt at repair should be made since the sutures will not hold in the edematous inflamed bowel wall and that the omentum may be brought down and tacked over the involved area and local drainage instituted. In some instances—for example when the actual site of

perforation cannot be found—it may be feasible to exteriorize the inflamed segment of bowel. Because fistula formation so frequently follows the above procedures it may be wiser to complement such operations with colostomy to shunt the fecal current and allow more rapid regression of the inflammatory process. When all inflammatory changes have subsided (and there is no evidence of obstruction) the colostomy may be safely closed.

The generalized peritonitis so frequently a part of the clinical picture of acute perforation should be treated by Fowler's position, nothing by mouth, adequate administration of fluids, electrolytes and protein, heat to the abdomen, small doses of morphine, and proper decompression. Distention may be relieved also by use of the rectal tube and the administration of 95 per cent oxygen by nasal catheter or B L B mask.

The use of sulfonamides both intraperitoneally and parenterally is now a regular and established part of the management of these lesions. They should be employed in full doses, with due regard for the untoward reactions.

In patients seen late after the onset of symptoms (after twelve to twenty four hours) the question of expectant symptomatic treatment must be carefully considered.

Chronic Perforation (Peridiverticular Abscess)

Abscess formation with localized peritonitis is the most common complication of the disease under discussion. Infrequently a palpable mass will gradually subside under conservative management (or fortunately perforate into an adjacent hollow viscus).

With abscess present it is wise to delay surgical intervention until the mass has become securely walled off. The best course then is the minimum of operative interference—simple incision and drainage. The latter may often be carried out extraperitoneally or per rectum. One should be careful not to enter the colon should this inadvertently happen. Shallow advises that cecostomy or colostomy be done at once.

After drainage with or without colostomy adequate time should be allowed for healing. This may take from four to six months to a year or more. After this resection may be necessary if the disease does not entirely subside.

The important thing to remember regarding the treatment

of diverticular abscess is that radical surgery should not be attempted in the presence of acute inflammation

Obstruction

Acute obstruction in this disease is rare chronic obstruction common In the more acute cases simple conservative surgical treatment consisting of colostomy or cecostomy is advised In addition of course measures already well established for combating bowel obstruction must be used as adjuncts adequate and prompt replacement of fluids electrolytes and proteins blood or plasma where indicated and the use of the sulfonamides With this treatment inflammation and obstruction usually subside and it is possible to restore the fecal circulation in four to six months The time of closure of the colostomy is best decided by the results of roentgenographic study with the barium enema

In the more chronic cases clinical judgment decides the optimum time for surgical interference One must consider such factors as the age and general condition of the patient the duration of the disease the extent of involvement and the degree of distention The operation of choice is colostomy first some distance above the mass I should like to point out parenthetically that the tendency of late is to provide some type of colostomy that completely diverts the fecal stream and to use the transverse colon more frequently Alton Ochsner's¹⁷ modification of Devine's colostomy answers the purpose admirably

The usual interval treatment should be carried out and after convalescence progress studies by means of the roentgenogram and sigmoidoscope will help determine the future course to be taken The stoma should not be closed for six to twelve months and the surgeon should be quite certain before closing the colostomy that there is no residual obstruction

If complete healing does not take place resection must be considered Here again the choice of procedure will depend on the condition of the patient and the extent of colon involvement If a small section of bowel is involved resection with end to end anastomosis can be performed In most cases it is probably safer to carry out excision of the affected bowel segment by an operation of the Paul Milulicz type Occasionally with very extensive involvement permanent colostomy may have to be recommended

Fistula

Anterior Abdominal Wall Fistula—Whether a peridiverticular abscess ruptures spontaneously or is opened surgically a fistula generally results. Most large bowel fistulas of this type will close spontaneously in the course of time. More persistent fistulas will frequently close after colostomy is done proximally. If after colostomy spontaneous healing does not occur resection of the fistula and the involved bowel will effect a cure.

Colo-rectal Fistula—This is another frequent and serious complication of diverticulitis. It occurred in 14.5 per cent of Rankin's³ forty-eight surgical cases, 15 per cent of Brown's¹⁸ series and 13 per cent of Lockhart Mummery's¹⁹ ninety-one patients who came to operation.

There is general agreement in the first essential in the treatment of this lesion—proximal colostomy. After a reasonable period devoted to applications of heat, frequent irrigations and proper dietary measures subsidence of the inflammation will usually take place. Operative correction will then consist of excision of the fistulous tract, closure of the bladder opening and in most instances resection of the affected segment of colon. Dixon⁹ often supplements this procedure with suprapubic cystostomy which is allowed to function for three to four weeks.

SUMMARY

Diverticula of the colon occur frequently—they are narrow-necked thin-walled herniations of mucosa covered by peritoneum beneath which there may be variable amounts of fat.

They are brought about by a combination of several factors acting on an area of bowel wall where some muscular weakness has developed related to the site of entrance of the blood vessels.

The principal factors usually associated with the onset of diverticulitis include straining at stool, the use of irritating cathartics and enemas and dietary indiscretions.

Surgical interference is demanded only for the complications. These include acute perforation of a diverticulum with peritonitis, peridiverticular abscess, obstruction and fistula formation.

The trend in surgical treatment has been toward conservatism, graded procedures being usually advised.

The incidence of carcinoma with diverticulitis is incidental rather than actual, but the chronic sclerosing inflammatory type may be difficult to differentiate from cancer.

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EXTENDING SURGERY IN THE TREATMENT OF CANCER OF THE COLON*

ALEXANDER BRUNSCHWIG MD FACST†

OPERATIONS for resection of carcinomas of the colon have for some time been more or less standardized. There is some variation in technic depending upon the level in the colon at which the neoplasm develops. Hepatic metastases are often regarded as contraindications to radical resection of the primary growth and colostomy above the obstructing or bleeding lesion is the usual practice. Where the primary neoplasm is relatively small and hepatic and peritoneal metastases not very extensive excision of the primary growth by either the exteriorization procedure or resection and end to end anastomosis may be carried out.

In some patients carcinomas of the colon may attain considerable size before gross evidence of metastases is present. Such neoplasms may extend locally to involve neighboring organs and tissues. When this has occurred the ultimate prognosis of course is guarded, since lymphatic and hemogenous spread beyond the gross limits of the neoplasm has usually developed. These situations however, should not deter the surgeon from an attempt at local excision of all macroscopic tumor. In some instances a surprising degree of palliation will be afforded in that the patient's general condition is improved because of removal of considerable parasitic tissue and obstructions are relieved. The lives of some of these patients are appreciably prolonged in comfort. Standard procedures cannot be described because of the wide variation in the findings at operation in patients with advanced cancer of the colon that has extended beyond the colon. Prior to inspection and palpation within the abdomen it is not possible to know what other organs and tissues are involved and hence definite preoperative plans cannot be formulated. Needless to add the excisions are carried out beyond gross limits of the tumor when possible and the secondarily involved tissues and organs are removed *en masse* with the primary growth.

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tomy through a small incision to the left of the main midline incision and the latter closed in layers

The surgical specimen consisted of most of the transverse colon bearing a large tumor mass spleen body and tail of the pancreas and omentum (Fig 33) The total weight was 1864 gm

Microscopic study of the tumor revealed adenocarcinoma

Convalescence was essentially uneventful until the thirty second day when a large abscess in the abdominal wall about the colostomy was discovered and drained The patient was discharged on the fifty seventh day with the colostomy functioning normally

At home the patient spent much time in bed but was also able to be up several hours a day Asthenia was progressive and appetite was always poor There was no evidence of bowel obstruction however and no pain The patient died at home the middle of March 1942 three and one half months after operation Several days prior to death icterus developed which became progressively severe

Case II Palliation Obtained by Resection of an Extensive Carcinoma of the Colon Closure of Colostomy Was the Urgent Desire of Patient

C. G. a white woman aged forty nine years was admitted to the University of Chicago Clinics January 4 1941 Two and a half years previously she had an attack of acute intestinal obstruction for which an emergency right sided (ascending colon) colostomy was performed in another institution Recovery was satisfactory and return to normal physical activity was possible but her existence was rendered very unhappy because of copious movements from the colostomy General physical examination was negative for evidence of carcinoma A barium enema revealed a typical filling defect of the splenic flexure characteristic of carcinoma

Operation was performed on January 9 1941 as follows

A high left rectus incision was made Palpation revealed a large mass in the splenic flexure (Fig 34 A) about the size of a large fist It was adherent to the anterior parietal peritoneum and to the posterior parietal peritoneum in this region It was also adherent to the hilum of the spleen and to the tail of the pancreas There were no apparent hepatic or peritoneal metastases The lateral peritoneal reflection of the descending colon was incised A circular incision was made about the adhesions

of the mass to the anterior parietal peritoneum freeing the latter with the mass. The right hand was passed over and behind the spleen and downward and by digital dissection the mass was elevated from the adhesions to the posterior abdominal wall. The spleen mass and tail of the pancreas were then elevated. A mass ligature was passed about the tail of the pancreas and splenic vessels 6 cm proximal to the tip of the tail and its adhesions to the mass. The pancreas was transected (Fig 34 B). During subsequent manipulations the mass was opened

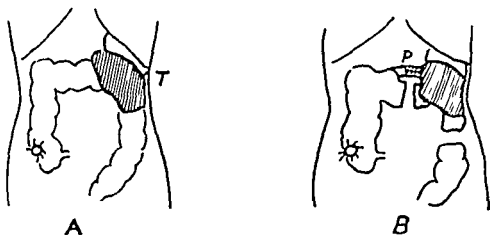


Fig 34 (Case II) —A Schematic presentation of condition on admission of patient. There is a functioning cecostomy; stools continuously liquid. This had been made two and one half years previously in another institution. T Large carcinoma involving the splenic flexure infiltrating the anterior parietal peritoneum in this region and posteriorly into the hilum of the spleen and tail of the pancreas.

B Showing the manner of resection of the carcinoma by transection of the transverse colon proximal to the growth of the upper descending colon distal to it and transection of the distal portion of the body of the pancreas. P The spleen tumor mass and portion of the body and tail of the pancreas were removed *en masse*. Double barreled colostomy at incision site and subsequent closure of both colostomies.

It became apparent that this was a large empty cavity lined by tumor. No colonic wall was identified; instead it appeared to have been replaced by tumor tissue that had extended outward. The spleen, tail of the pancreas and mass were then exteriorized (Fig 35). The afferent loop to the mass consisted of the left portion of transverse colon; the efferent loop consisted of the midportion of the descending colon. Pylor clamps were applied and the mass was resected. Iodoform gauze packs were applied about the closed 'double barreled' colostomy and the remainder of the wound was closed in layers.

Convalescence was complicated by a deep left flank and left subdiaphragmatic abscess which were drained. The patient was discharged on the thirty fourth day with the wound healed and an open left sided colostomy. Bowel movements continued through the right colostomy.

Four and one half months later the patient was readmitted and both colostomies closed at the same sitting.

Following the last discharge the patient's condition appeared quite satisfactory for several months and the absence of colos-



Fig 35 (Case II) - Photograph of the specimen removed at operation in detail in Figure 34. The tumor mass has been opened and reveals a large central cavity. It is bounded by a rim of neoplastic tissue. The tumor has extended beyond the limits of the pre-existing colon in this region. No evidence of the colon is present. Instead the lumen of the colon in this region is surrounded by tumor. The discolored portion of the pericreas surrounded by areolar tissue which is adherent to the large tumor mass and was resected *en masse* with it.

tomies was a source of considerable satisfaction. However on February 24, 1942, eight months later she was readmitted stating that for the past week there was frequent vomiting, more or less continuous abdominal pain and extreme weakness. Examination revealed no masses or fluid in the abdomen but some resistance in the left upper quadrant. Marked asthenia was progressive during the next four days and the patient expired March 1, 1942.

Necropsy revealed extensive intra abdominal and pulmonary

Case III Appreciable Palliation by a Series of Operations for Recurring Cancer of the Colon

C. B. a white man aged forty eight years was admitted to the University of Chicago Clinics January 13 1941 complaining of pain in the right lower quadrant, anorexia a weight loss of 15 pounds during the previous two months and occasional vomiting for six weeks. A year previously an appendectomy was performed in another institution for persistent right lower quadrant pain but this operation did not relieve the symptoms. On physical examination an oval mass was palpated beneath the appendectomy scar. Barium fluoroscopy revealed a constricting lesion in the cecum.

First Laparotomy—On January 22, 1941 laparotomy was performed through a low right rectus incision. A tumor mass about 8 cm in diameter was found in the cecum and several loops of ileum were adherent to it (Fig. 36 A). No metastases were present in the liver or over the peritoneum. Numerous large firm lymph nodes were palpable in the mesentery of the small bowel and about the aorta. One of them was removed for biopsy and an ileotransverse colostomy was performed.

Convalescence was uneventful and the patient was discharged on the seventeenth day postoperative. X-ray therapy was given to the right lower quadrant from February 6 to March 3 1941 and from June 13 to July 19 1941.

The patient was readmitted August 4 1941 complaining of severe right lower quadrant pain of five days duration. Up to that time he had been quite active physically and felt well except for a weight loss of 20 pounds since the previous operation. Examination of the abdomen revealed marked rigidity in the right lower quadrant over a mass and a chronic sinus in the old appendectomy scar. The drainage was purulent and not fecal. Temperature 98.8 F. white blood count 8400. The sinus was spread open to a greater degree to facilitate drainage and the patient was discharged.

He was again admitted October 5 1941. The mass in the right lower quadrant was larger. The liver was not palpable and there was no evidence of ascites.

Second Laparotomy—On October 9 1941 laparotomy was again performed as follows.

A long elliptical incision was made in the right lower quadrant 7 cm at its greatest width. This included the skin of the lower right abdominal wall about the draining appendectomy scar which was apparently adherent to the subjacent mass and

the muscle and fascia of the abdominal wall between the skin and the deeper mass. When the abdominal cavity was entered

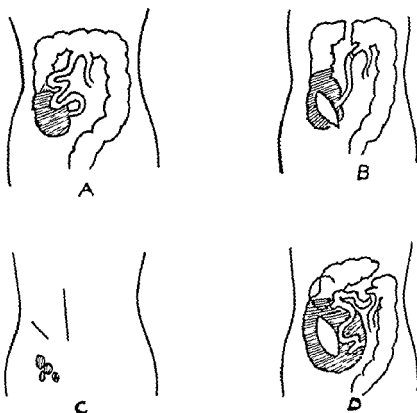


Fig. 36 (Case III) —A Findings at laparotomy January 1941: large carcinoma of the cecum with loops of small bowel adherent. An ileotransverse colostomy was done.

B Operation October 1941 at which time an elliptical portion of the abdominal wall in the right lower quadrant was removed and a resection of the invading tumor cecum ascending colon right transverse colon and 10 cm of the jejunum was performed. The previous ileotransverse colostomy was undisturbed.

C The situation in June 1942 showing the superficial inguinal lymph nodes containing metastatic carcinoma. These were resected.

D The last operation performed in May 1943 showing the large tumor mass in the right side of the abdomen extending anteriorly into the abdominal wall of which a large elliptical portion was resected as shown extending upward to surround the previous ileocolostomy and backwards into the posterior abdominal wall. The neoplasm and surrounding bowel were removed and a second ileotransverse colostomy performed.

the cecal mass was found not to be adherent to the loops of small bowel as was the case at the first laparotomy. The site

of the ileocolostomy was inspected and found to be in good condition. Incision was made in the lateral peritoneal gutter and the cecal mass, ascending colon and hepatic flexures were mobilized. There were dense adhesions to the muscles of the iliac fossa of the right pelvis and these were separated by sharp dissection. The transverse colon and ileum were transected just to the left of the ileocolostomy and the mass was removed (Fig 36 B). Closure of the wound was difficult because of excision of skin, muscles and fascia of the abdominal wall. Extensive undermining of the layers about the wound finally permitted its closure under tension. Convalescence was uneventful.

During the late fall and winter of 1941-42 the patient traveled in the southwest and felt quite well.

On June 15, 1942, he was readmitted complaining only of a swelling in the right groin. Examination revealed this to be several large firm inguinal nodes (Fig 36 C). On June 16 a radical resection of these nodes *en masse* was performed and he was discharged a week later.

On April 14, 1943, the patient was again admitted complaining of lower abdominal pain, nausea, vomiting and intermittent diarrhea. These symptoms had been present intermittently for a month. Examination of the abdomen again revealed a large firm mass in the right lower quadrant which extended upward and toward the midline to beneath the umbilicus. The skin over the right lower quadrant appeared once more adherent to the underlying mass. The abdominal wall in the right lower quadrant was edematous and adherent to the mass. The liver was not palpable and there was no evidence of ascites. Roentgenograms of the chest were negative.

Third Laparotomy—On May 4, 1943, laparotomy was again performed. An elliptical incision was again made in the right lower quadrant to include that portion of the abdominal wall that appeared to be adherent to the underlying mass. When the abdomen was opened, an irregular mass of tumor tissue about double fist size was encountered in the right iliac fossa. Adherent to it were several loops of ileum. The ileocolostomy was drawn downward and into the right iliac fossa and appeared to be surrounded by irregular neoplastic infiltration. Large firm nodes were present in the mesentery of the small bowel extending upward to the origin of the superior mesenteric artery. The mass infiltrated backward into the posterior abdominal wall surrounding the right ureter. There were no hepatic metastases. The mass was elevated by dissection proceeding from the right

lateral peritoneal gutter medially the right kidney ureter mass, and several loops of small bowel adherent to it were freed (Fig 36 D) During the freeing of the mass from the posterior wall of the right pelvis the right common iliac vein was cut and ligated The left portion of the transverse colon was transected and invaginated The small bowel was transected at a level that appeared to be high in the ileum or in the lower jejunum and the end invaginated A side to side ileotransverse colostomy was performed after the mass described above was removed Closure of the abdominal wall was again difficult but

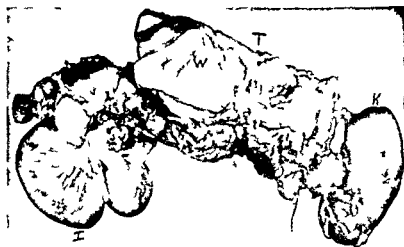


Fig 37 (C e III) —Photograph of surgical specimen removed at final operation showing T recurrent tumor mass infiltrating the anterior abdominal wall resected with the tumor K the right kidney 86 cm of small bowel 29 cm of colon closely adherent to the tumor mass and is not shown separately

was accomplished with much tension at the wound edges Five soft rubber drains were placed to different portions of the extensive excision site and brought through the wound

Study of the surgical specimen revealed it to include in addition to the irregular tumor mass right kidney and ureter adherent portion of abdominal wall 86 cm of ileum and 29 cm of colon (Fig 37)

Immediate convalescence was essentially uneventful The highest temperature was 101 F on the second day The right leg was cyanotic and cold on palpation for three days although it was not painful By the tenth day the wound had separated

completely and was covered by a large pressure dressing. By the end of the second week little food was being consumed and he was irrational at intervals. However, evidence of beginning wound healing was apparent. His general condition remained only fair but the temperature and pulse were normal. On the afternoon of twenty third day postoperative he was found dead by the nurse. The sudden death was unexpected as he appeared to be improving. Necropsy revealed a coronary occlusion also carcinomatous retroperitoneal lymph nodes.

A review of this patient's history with the several operations might convey the impression that he was markedly debilitated during the two years and three months since first admission to this hospital. This was not the case, however, since the only periods he was confined to bed were during the immediate postoperative periods. He was up and physically active during most of his survival period and, as stated, made an extensive pleasure voyage during the winter of 1941-42. I feel that we were too conservative at the outset in this instance in that a short circuiting operation was first performed instead of a massive resection.

Case IV Radical Operation in Secondary Cancer of Colon and Small Bowel with a Degree of Palliation That Was Unanticipated

J. G., a white man aged thirty seven years, was admitted to the University of Chicago Clinics in April 1940 with carcinoma of the stomach (Fig 38 A). A radical gastrectomy (Polya type) was performed April 22, 1940. Recovery and postoperative course were uneventful until December 1941 when he was readmitted presenting a distended abdomen and complaining of nausea, vomiting and abdominal pain. An epigastric mass was palpable.

Operation on December 27, 1941, was performed as follows (Fig 38 B).

1. Excision of high midline incision scar. Palpation and inspection within the abdomen revealed a half fist size recurrent carcinomatous mass in the midtransverse mesocolon and infiltrating the colon wall producing partial obstruction (Fig 38 B). In the lower descending colon was another but smaller carcinomatous mass also constricting the lumen. In the upper jejunum there was neoplastic infiltration of the mesentery near the bowel and extending into the bowel wall itself for a considerable distance. In the lower ileum a similar condition was

found over a shorter segment. It was obvious that the upper abdominal mass was a recurrence in the previous operative field. The gastroduodenal anastomosis was free from tumor. The two lesions of the small bowel and that of the lower colon were gravitation metastases primary in the mesentery near the bowel and involving the latter by lymphatic permeation. The bowel wall in the affected segments was thickened and firm and covered with fibrinous exudate. In the small bowel the appearance suggested regional ileitis. No hepatic or other peritoneal extensions were found.

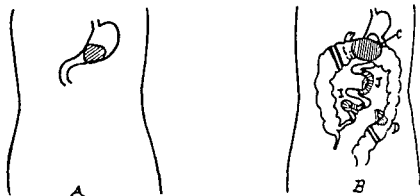


FIG. 38 (Case IV).—A Situation of the carcinoma of stomach which was resected in April 1940.

B The situation of the second operation in December 1941 with the location of tumor in the small intestine and the location of the carcinoma of the stomach. D Neoplastic infiltration of segment (J) in upper jejunum and of segment (I) in lower jejunum.

At operation most of the tumor was removed to include the caecum and the right half of the colon, the right half of the transverse colon, the right half of the descending colon, segments J measuring 5 m and I measuring 15 m. The remaining part of the small intestine was closed by suture and end-to-end anastomosis respectively. The colonotomy was closed.

2 Excision of involved segment of upper jejunum and mesentery. Side to side entero-enterostomy.

3 Excision of involved segment of lower ileum and mesentery. End to end anastomosis.

4 Transection of colon near the hepatic flexure with mobilization of the latter.

5 Transection of colon at junction of descending and sigmoid portions. Resection of most of transverse colon, splenic flexure and entire descending colon with recurrent neoplasms adherent.

6 The proximal and distal loops of colon were brought through the abdominal wall in a stab incision to the left of the midline incision. The latter was closed in layers.

The surgical specimens consisted of 50 cm of colon bearing the two carcinomatous masses, 35 cm of jejunum bearing the carcinomatous mass and 15 cm of ileum with its carcinomatous mass. In the latter two specimens there were ulcerations in the mucosa. The smaller carcinomatous mass in the lower descend

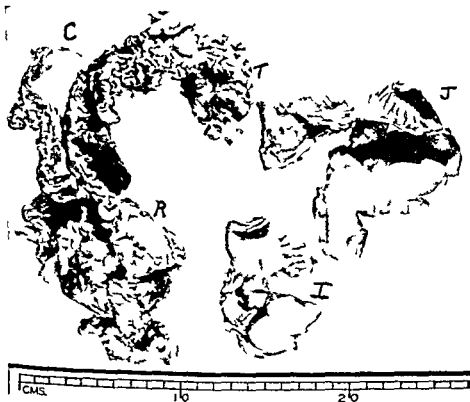


Fig 39 (Case IV) —Photograph of surgical specimens removed at operation shown in Figure 38. C Transverse and descending colon with tumor masses R and T. J Segment of jejunum and I segment of ileum each bearing metastatic ulcerating tumor masses.

ing colon also ulcerated the mucosa. The large mass in the transverse colon did not extend through the bowel wall to cause ulceration (Fig 39).

Convalescence was uneventful. The patient was discharged twenty three days after operation with the colostomy functioning normally. The latter was closed eight weeks later. Since then the patient has returned to work and has worked continuously without discomfort. He is 15 pounds heavier than at the first admission and at this writing two years after the

second operation he is at work as a sailor on a Great Lakes ore steamer

Case V Radical Excision of a Carcinoma of the Colon That Had Spread into the Abdominal Wall and onto the Stomach

J C a white man aged sixty six years was admitted to the University of Chicago Clinics June 23 1942 complaining of weakness a sense of weight in the abdomen and the loss of 20 pounds in weight during the past year During the past six weeks he noted a small amount of blood on several occasions in the stools

Physical examination revealed a thin subject with a large oval mass in the upper abdomen the lower border of which was at the

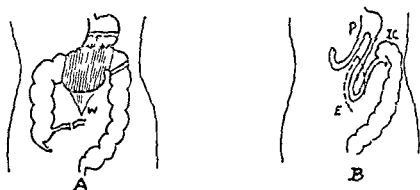


Fig 40 (C e V) —A Schematic representation of large carcinoma arising in the transverse colon extending below and into the lower portion of the abdomen and forward in the left flank to invade the anterior abdominal wall reaching the deeper portions of the skin about the umbilicus (B) Line of incision for removal of the growth are shown the stomach splenic flexure and lower ilium

B Situation after operation The mass has been removed together with an elliptical portion of the abdominal wall about the umbilicus indicated by dotted line E The continuity of the alimentary canal has been reestablished by a Polya gastrojejunostomy P and a transverse ileocecectomy IC near the splenic flexure

umbilicus The latter was puckered and felt much firmer than normal when the finger was inserted into it There was no ascites and the liver was not palpable Blood pressure 136/74 red blood cells 4 800 000 leukocytes 17 000 The Wassermann and Kahn reactions were negative Barium enema fluoroscopy showed a filling defect 7 cm long in the midportion of the transverse colon

Diagnosis Carcinoma of the transverse colon

Operation (Fig 40 A) was performed on June 25 1942 under continuous spinal anesthesia as follows

1 A high midline incision was made and the peritoneal cavity opened. It became immediately apparent that the mass in the transverse colon was much larger than expected. It was obviously a carcinoma that had extended upward and backward in the gastrocolic ligament to invade the greater curvature of the stomach and it extended forward and downward in the falci form ligament, reaching the deeper portions of the umbilicus. Palpation of the liver failed to reveal metastases. There was

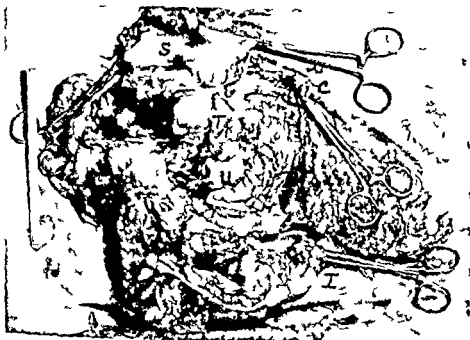


Fig 41 (Case V) —Surgical specimen removed as indicated in previous figure. S Lower portion of stomach T Large carcinoma arising in the transverse colon C Lower limit of resection of colon just proximal to splenic flexure I Limit of resection of lower ileum about 15 cm above ileocecal valve U Skin about umbilicus showing the tumor extending up into this portion of the abdominal wall. A larger segment of the abdominal wall had been removed but was cut away prior to photographing the specimen in order to obtain a better view of the tumor itself.

no gross evidence of peritoneal spread or gravitational metastases in the pelvis. In order to encompass the umbilical spread a triangular incision in the skin about 4 cm. to each side about the umbilicus was made and joined to the midline incision. The latter was extended downward for 5 or 6 cm. below the lower border of the umbilical incision.

2 It then became obvious that to resect the tumor and its extensions the lower one third of the stomach, most of the transverse colon, ascending colon and cecum and periumbilical

region of the abdominal wall would have to be removed *en masse*. Accordingly the pylorus was transected and duodenum invaginated. The stomach was transected in the midportion. Following this step the lower half of the stomach adherent to the carcinoma was freed.

3 The ileum was transected 10 cm. above the ileocecal valve and cecum, ascending colon and hepatic flexure were mobilized by division of lateral leaf of the mesentery and hepatocolic ligament. The transverse colon was transected about 6 cm. to the right of the gross limits of the neoplasm.

4 Resection of cecum, ascending colon, two thirds of the transverse colon, lower one third of the stomach and periumbilical portion of anterior abdominal wall was carried out *en masse*.

5 Ileotransverse colostomy, side-to-side and gastroenterostomy (Polya) terminated the operation.

6 Closure of the abdomen without drainage. The situation after operation is shown in Figure 40 B.

The specimen (Fig. 41) weighed 1030 gm. Histologic study revealed adenocarcinoma of the colon.

Convalescence was uneventful and the patient was discharged on the eighteenth day after operation, ambulatory. One year after operation the patient had gained 12 pounds in weight and was well and physically active with no complaints. One year and five months after operation his general health remains good and he is normally active, partaking of a full regular diet. Stools are normal.

PREOPERATIVE AND POSTOPERATIVE CARE IN EXTENSIVE RESECTIONS OF CARCINOMA OF THE COLON

Preoperative Care

The general principles of preoperative and postoperative care are applicable to patients undergoing the procedures described in this clinic. Special attention should be paid to the *nutritive state* and where this is obviously poor, measures should be undertaken to rectify to some extent the deficiency. Prolonged hospitalization for this purpose is not feasible, however, and often cannot be even considered because of the bowel obstruction.

A state of dehydration is rapidly corrected by parenteral administration of 5 per cent glucose and normal saline in daily quantities sufficient to bring the urine output to 1000 to 1500 cc. each twenty-four hours.

Anemia (erythrocyte count below 4 million) is corrected by transfusions of whole blood

Vitamin preparations are administered if there is a history of prolonged limitation of appetite

Plasma proteins should be determined preoperatively and if they are low (below 6 gm per cent) plasma transfusions are indicated

In the absence of appreciable obstruction I prescribe 60 cc of castor oil at night and 60 cc of 50 per cent magnesium sulfate in the morning beginning seventy two hours before operation No cathartics are given twenty four hours prior to operation No enemata are prescribed

Whenever possible *continuous spinal anesthesia*, supplemented if necessary by ethylene or ether or both is employed Spinal anesthesia is without question a most important factor in obtaining favorable results because of the marked relaxation which it facilitates Supplementary general anesthesia is not used unless its need is clearly apparent

At the beginning of the operation *fluid* usually normal saline solution is started intravenously Depending upon the amount of blood lost *blood transfusions* are also given by the same set up Blood pressure is the principal guide for the administration of fluids and blood If possible the systolic blood pressure is maintained at not less than 100 mm of mercury It may fall to 80 or 70 during the operation even though infusions are in progress but this in itself is not an alarming factor

It cannot be emphasized too strongly that adequate blood transfusions are of paramount importance in combating shock in these patients Frequently transfusions of 2000 cc of whole blood with 1000 cc of plasma may be necessary and these quantities can and should be exceeded if conditions require it It is unfortunate that in some quarters it is felt that the amount of citrate in the blood represented by these quantities is harmful and that blood transfusion should be limited This limits the surgeon in his endeavors to extend operative attack on large resectable neoplasms

Postoperative Supportive Measures

The usual postoperative fluids are given to insure adequate fluid balance Since during the immediate postoperative period large quantities of nitrogen are lost representing protein catabolism it would appear that partial or complete compensation for

this is desirable especially in debilitated patients. This is possible by the administration of casein digests (amigen). The latter may be given with glucose (5 per cent amigen plus 5 per cent glucose). In total amounts of 2000 cc a day this represents 100 gm of the digest (12 gm of nitrogen) and 100 gm of glucose to the equivalent of 760 calories. Larger quantities may also be given to the equivalent of 1700 to 1500 calories or more.

It is our impression that smooth convalescence is favored by withholding fluid and food by mouth for several days following operation. Routinely nothing is permitted for four or five days. On the fourth or fifth day 30 cc of water an hour is given and this is increased to 60 cc of water or clear liquids the following day. Return to a soft diet is permitted gradually over a period of five to seven days. Patients in relatively good condition tolerate such periods of starvation. To debilitated subjects parenteral amigen and glucose are given daily until adequate food is taken by mouth. We have maintained patients for thirty days on casein digests, glucose and saline intravenously with nothing by mouth.

CONCLUSIONS

1. Advances in supportive treatment, knowledge of nutrition and anesthesia contribute to an extension of the surgical attack upon carcinoma of the colon.

2. In the absence of diffuse hepatic and peritoneal metastases, carcinomas of the colon that have extended to adjacent viscera and tissues may be excised *en masse* with the extensions.

3. Carcinoma of the colon that has extended locally to adjacent viscera and tissues represents an advanced stage of the disease and the ultimate prognosis is poor; yet successful resections are not infrequently followed by surprisingly gratifying palliative results. Such procedures therefore seem justified.

INTUSSUSCEPTION

J J MUSSIL MD

INTUSSUSCEPTION is the telescoping of one portion of the intestine or colon into a more distal segment of the bowel and is one of the most frequent surgical emergencies in children under two years of age. In order to understand the variations in the symptomatology of these cases we may well take the time to review the etiology and mechanism of this interesting phenomenon.

ETIOLOGY MECHANISM OF PRODUCTION

The etiologic factor is still somewhat obscure in the majority of instances. In about 5 per cent of cases there is demonstrable some mechanical abnormality of the bowel such as a Meckel's diverticulum or an intestinal polyp but in the remainder of the cases the etiologic factor cannot be demonstrated. With increasing knowledge of the behavior of the bowel however it is now possible to piece this knowledge together and visualize with a reasonable degree of accuracy just what probably happens in the latter cases. Any satisfactory explanation of this phenomenon must account for the fact that over 80 per cent of cases of intussusception occur in infants under two years of age and in the region of the ileocecal valve. Perrin and Lindsay found that the ileocecal valve in young infants projects about $\frac{3}{8}$ inch into the cecum and that the mucosa of the terminal 5 or 6 inches of ileum is heavily studded with lymphoid follicles. In general these lymphoid follicles and glands of the lower end of the ileum are swollen owing undoubtedly to a mild asymptomatic enteritis. In fact it has been noted that many of these cases occur during or shortly after an attack of acute enteritis with the region of the ileocecal valve bearing the brunt of the disturbance.

It has been observed also that nearly all cases of intussusception occur in robust infants the majority in males whose bowels are capable of powerful contractions. Furthermore Alvarez has established experimentally that the stimulus for peristaltic waves is myogenic in origin and that the excitability of intestinal musculature varies with its physical state. Any localized irritation of the bowel will induce a hyperexcitability of the musculature.

with a resultant spasm I frequently observed this very phenomenon upon the production of intussusception experimentally in dogs by means of a glass rod. In the attempt to invaginate the bowel the rod irritated the bowel sufficiently to produce a powerful localized spasm or constriction. The constriction was from $\frac{1}{2}$ to 1 inch in length and reduced the size of the bowel to about one third of its usual diameter.

Now any localized irritation such as an inflammation of the lymphoid follicles or as some have suggested irritation due to dietary change because the majority of cases occur between the third and ninth months when the infant's diet is changed from milk to more solid foods may cause a powerful localized spasm or constriction adjacent to or at the site of irritation. This in my opinion at least partially gives rise to the first cardinal sign of intussusception namely a *sudden paroxysm of pain* in a previously happy child. Peristaltic waves approaching the constricted segment of the bowel are unable to pass and thus the stage is set for the invagination. In attempting to pass the constriction which in fact is an obstruction the waves increase in severity until a powerful wave finally carries the small constricted segment into the relaxed and larger distal segment. The constricted segment now becomes the head or apex of the intussusception and is carried forward in the bowel by succeeding waves.

The progress of the intussusception is limited largely by the anatomy of the affected portion and the degree of hyperexcitability of the bowel above it from which it derives its impetus. Thus if the intussusception occurs in the ileum—the so-called ileoileal type—it will in all probability be short because both segments being of the same diameter the tension inside soon becomes too great for further progress. On the other hand if the intussusception occurs at the ileocecal valve—the so-called ileocecal type which is the most common—it may advance rapidly and to a great length because of the marked difference in the diameters of the cecum and ileum.

The pathology and symptomatology from this point is based entirely on the mechanical interference to the blood supply of the affected segment of the bowel. As the invaginated segment is carried forward by succeeding peristaltic waves mesentery and blood vessels are dragged along and swallowed up with an ever increasing pressure on the vessels. As a result of this pressure the venous return is impeded first and the intussuscepted

portion becomes engorged with blood especially at the head the furthest point of advance of the intussusception. The congestion of the mucosa causes a *profuse secretion of clear mucus which is admixed with blood* from rupture of the engorged venous capillaries of the intestinal villi. This mucus, which is stained uniformly throughout with bright red blood has been described so aptly by Montgomery as the currant jelly type. Thus there is presented the second of the cardinal signs of this condition in fact sometimes it is the only sign present. Case I illustrates this point beautifully.

CASE I.—C. H. a Negro boy aged four months was admitted to Children's Memorial Hospital October 17, 1943 with a history of blood in the stools for two days. The mother stated that the first warning of anything amiss was given with the finding of a clot of blood in the morning stool. She gave the baby an enema and more fresh blood was obtained. At noon the child passed about one half cup of mucus mixed with blood. At 8:00 P. M. another stool of mucus with blood was passed and the child vomited. From then on every stool contained currant jelly like mucus. At no time did the child cry or show any sign that he was in pain. The child had been breast fed since birth.

Physical examination on admission was entirely negative except for bloody mucus obtained with each rectal examination. The child was happy and playful frequently smiling at the examiner. There was no suggestion of a mass anywhere in the abdomen and it was suggested that this might be an intussuscepted Meckel's diverticulum.

This child was observed for two days during which time he vomited several times and continued to pass mucus stained with blood. At no time during this period did he show any sign of pain. Because of the continued blood in the stools however an exploratory operation was decided upon four days after the initial appearance of blood.

Under ether anesthesia the abdomen was opened through a right rectus incision and an intussusception in the region of the ileocecal valve was noted. When the cecum was grasped to deliver it into the wound the intussusception reduced itself. On inspection the terminal 5 or 6 inches of the ileum showed signs of passive congestion but no induration or edema which probably accounted for the fact that the mass was not palpable.

The postoperative course was uneventful except for a temperature rise to 104.4° F. during the night following operation.

The condition may not progress further in which case it may reduce itself or the bowel will continue to function normally.

as demonstrated in experimental animals by Montgomery and Mussil and there results the so called chronic intussusception. Case II illustrates this point

CASE II—W D a white boy aged eleven months was admitted to the Children's Memorial Hospital with the following history Since the age of three months the patient has had four attacks of abdominal pain vomiting and blood in the stools each attack lasting about one day during which time he refused to take his feedings and at intervals would draw up his legs and cry in apparent pain He would vomit once or twice and following this would appear relieved of his pain The stools passed during this period consisted almost entirely of mucus stained with bright red blood

This child was breast fed for the first nine weeks and then changed to whole cow's milk with cereals at four months and vegetables at five months

Physical examination on admission was essentially negative There was no tenderness or mass on palpation Urine was negative red blood cells 35 million white blood cells 10 000 and hemoglobin 65 per cent X ray study following a barium enema revealed a characteristic smooth concave obliteration in the cecum Because the subjective symptoms had subsided a diagnosis of intussusception with spontaneous reduction was made and the child was sent home

He was readmitted two days later with another attack similar in all respects to the previous attacks

The physical examination was again negative No mass could be demonstrated but because of the past history an immediate operation was advised

Under ether anesthesia the abdomen was opened revealing an intussusception beginning with the terminal 6 inches of the ileum and extending to the midportion of the transverse colon

The postoperative course was uneventful except for a temperature rise to 104° F on the second day

If the venous supply is further impeded the head of the process becomes progressively more edematous until the lumen of the bowel becomes completely occluded and a real obstruction develops This is accompanied by recurrent colicky pain distention and accumulation of toxic products in the bowel above Finally as the pressure is increased either by the ever increasing edema or by the gradual advancement of the process the arterial blood supply to the most distal segment becomes shut off and gangrene of that segment results Now if there is still no surgical intervention the gangrenous portion will slough off and pass out through the rectum the peritoneal surfaces in

apposition become agglutinated and the patient recovers. However in the experimental animal the lumen of the resulting stump has a tendency to close gradually by cicatricial contraction giving rise to a chronic obstruction. In the less favorable cases which are far more common, the gangrene results in leakage with suppurative peritonitis and death.

CLINICAL PICTURE

The clinical picture of intussusception is usually quite clear a fortunate fact as the outcome depends on an early diagnosis. A history of a sudden outcry from a *severe paroxysm of pain* followed by vomiting, in a previously happy and robust child under two years of age should immediately suggest the possibility of intussusception. This initial attack is soon followed by recurrent colicky spasms of pain at variable intervals during which time the child draws up his legs in obvious pain and becomes quite pale. After a few hours there usually appears the picture of shock with pallor, sweating and dehydration which increases in severity with the passing of each hour.

Following this first phase in about 85 per cent of cases *blood intimately mixed with mucus* is passed by rectum or may be seen on the examining finger. The amount of bleeding varies considerably with the individual case. It may be just enough to stain the mucus red or it may be severe enough to produce clots. This 'currant jelly' like mucus is considered by many almost pathognomonic of intussusception. The time of its appearance varies considerably and depends entirely on the type of intussusception and the rate of its progress. In the ileocecal type it usually appears early, but in the purely ileoileal type it may not appear for a day or two.

Coincidentally with the appearance of the bloody mucus a *mass* can usually be palpated in the abdomen along the course of the cecum and transverse colon. Seldom is it found in the right iliac fossa, as the cecum in small children is mobile and always relatively high. Furthermore it is carried up by the invaginating process in the ileocecal variety. In the ileoileal type the mass is usually found in the hypogastrium and may be difficult to detect especially in the early stages before it has acquired the firmness that comes with the developing edema. In cases of doubt a barium enema followed by x ray may reveal a characteristic cupping in the type involving the large bowel only. Obviously it will be of no practical value in the ileoileal variety.

DIAGNOSIS

The diagnosis in the average case is relatively simple. As blood in the stool is the most consistent finding one must rule out all conditions that produce bleeding into the bowel such as severe enterocolitis, Meckel's diverticulum, rectal polyp, and Henoch's purpura. However, since there are few illnesses in children in which the clinical history and physical findings are so consistent, a correct diagnosis should be made without much loss of time, a factor so important in the prognosis.

TREATMENT

The treatment is immediate operation. The methods of reduction by hydrostatic means or air pressure are to be condemned because of the danger of rupture of the bowel. Barium enema controlled by fluoroscopy has some merit especially in the ileocecal variety, but obviously is of no value in the ileoileal type, and one can never be sure that all of the invagination is reduced even in the former type. Immediate operation is therefore the treatment of choice. In the great majority of cases the invaginated bowel can be reduced without much difficulty or trauma. The ease with which it can be reduced depends directly on the interval between the onset and the time of operation. Generally speaking, the mortality rises rapidly after the first twelve hours have elapsed.

In those cases in which the entire intussusception cannot be reduced, owing largely to presence of edema, it has been our experience here at the Children's Memorial Hospital that the method of lateral anastomosis around the mass offers the best chance for recovery. Case III illustrates this point and also the postoperative course that one may expect.

CASE III—C. A., a white boy aged thirteen months, was admitted to the Children's Memorial Hospital February 14, 1943, with a history of having been perfectly well until yesterday morning when suddenly he fell to the floor screaming with pain. This lasted for about five minutes, following which he became limp and listless. This was repeated several times during the morning, and about 10:00 A.M. a local physician was called who diagnosed it enterocolitis and administered some medicine, but the child promptly vomited this. The child continued to have pain and to vomit during the remainder of that day and night up to the time he was brought to this hospital.

On admission the child appeared acutely ill with a temperature of 101° F. Palpation of the abdomen revealed tenderness over the entire right side with a definitely palpable and movable mass. Rectal examination revealed blood stained mucus on the examining finger. A diagnosis of intussusception was made and immediate laparotomy was advised.

Under ether anesthesia the abdomen was opened revealing a section of ileum intussuscepted through the ileocecal valve and extending to the hepatic flexure of the ascending colon. The colic portion of the invaginated bowel was reduced without difficulty but the ileac portion presented great difficulty because of the associated edema. The serosa of the ileum began to split and finally all attempts at reduction had to be abandoned because of the danger of perforation with about 6 inches of ileum still invaginated. The invaginated bowel was fixed in place by a few silk sutures and a lateral anastomosis of ileum to ileum was done around the mass. The abdomen was closed without drainage and the child returned to his bed.

The postoperative course was very stormy. The temperature rose to 103.6° F and then fluctuated between 102° and 103° F until the ninth day when it went to 106.4° F. The child appeared extremely toxic and this was explained on the basis of toxic absorption from the gangrenous section of the bowel. On the twentieth postoperative day he began to pass large quantities of bright red blood with each stool which was assumed to be due to the sloughing of the gangrenous segment of the bowel. He improved slowly and was discharged as completely well March 23, 1943, thirty seven days after operation.

Tables 1 and 2 summarize 105 cases of intussusception seen at the Children's Memorial Hospital during the ten year period of 1933-1943.

TABLE 1
INCIDENCE OF INTUSSUSCEPTION ACCORDING TO AGE

Age	Cases	Age	Cases	Age	Cases	Age	Cases
1 month	1	9 months	8	17 months	2	2 to 3 yrs	3
2 months	4	10 months	5	18 months	0	3 to 4 yrs	4
3 months	4	11 months	4	19 months	1	4 to 5 yrs	2
4 months	10	12 months	5	20 months	1	5 to 6 yrs	0
5 months	9	13 months	4	21 months	1	6 to 7 yrs	1
6 months	6	14 months	2	22 months	1	7 to 8 yrs	1
7 months	6	15 months	2	23 months	1	8 to 9 yrs	1
8 months	10	16 months	2	24 months	3	9 to 10 yrs	1

TABLE 2

DURATION OF SYMPTOMS AND MORTALITY STATISTICS

Symptom Duration	Operative Results			
	Total Number of Case	Survivals	Death	Mortality Percentages
0 to 24 hrs	44	44	0	0
24 to 48 hrs	27	20	7	26
48 hrs and over	34	23	11	32
Total	105	87	18	17

SURGICAL TREATMENT OF ULCERATIVE COLITIS*

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and

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PATHOLOGICAL CONSIDERATIONS

ULCERATIVE colitis is an infectious process of the colon which can be divided into two distinct types (1) the mild or superficial type which either affects only the mucosa or does not penetrate the deeper parts of the colon and (2) the more severe type which not only ulcerates the mucosa but infects the submucosa the muscularis and all the muscle layers of the bowel wall infiltrating the tissue of the bowel wall and producing a marked infection of the lymph glands and its mesentery. Clinically, the mild cases show few clinical signs beyond the appearance of stools mixed with pus and a small amount of blood the stools varying in number from two to four a day. This condition will usually last from three to six weeks sometimes eight to ten, and then subside. The patient clinically does not seem toxic or septic or very much affected in appearance but he has attacks from time to time usually two or three in one year.

On the other hand, the chronic and severe infiltrative type of ulcerative colitis in which all of the bowel wall is involved has practically no or only slight remissions. The patient is toxic and septic with recurrent embolic infection, bronchial symptoms swollen painful joints especially in the knees and the elbows and sometimes in the shoulder. Marked anemia and loss of weight are features the patient often being reduced to less than one half his normal body weight. The stools contain large quantities of blood and pus and vary in number from five to twenty five a day.

The stools in severe cases of ulcerative colitis may be classified in two groups—those in which pus predominates and only a moderate amount of blood is present and those which have blood with only a small amount of pus. Proctoscopy in the type in which pus predominates reveals a great deal of grayish exudate

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and a fair amount of ulceration while in the hemorrhagic type the whole mucosa is dotted with multiple bleeding points with many small ulcers and the entire mucosa surface of the colon appears bloody and red. It seems that one or the other type will predominate.

The colon within a few months to a year is completely destroyed functionally becoming simply a tissue structure permeated with pus. The lumen is contracted. There are no areas of healing and the cicatricial formations produce multiple strictures in the bowel. The bowel wall becomes markedly thickened and infiltrated and the contraction occurs in the length of the colon as well as in the circumference as a result of the infiltration. The splenic and hepatic flexures completely disappear as well as the flexure of the sigmoid. The colon in reality loses one third of its length and resembles a horseshoe in shape when the abdomen is opened.

If the disease persists for a number of years the colon loses most of its mucosa and all that is left are islands of mucosa which usually have the appearance of polyps. This is known in its later stages as the ulcerative polyloid type of colitis. In areas in which the mucosa is completely sloughed away the bowel has the appearance of granulation tissue. Many of the cases develop such marked strictures within a few inches of the anus that careful sigmoidoscopic examination is impossible.

It is interesting to note that in the cases with infiltration which have lasted for many years a tremendous amount of fat deposits is present in the epiploicae and the surrounding peritoneum of the colon although the patient is greatly emaciated and has lost more than one half his body weight. It has always been our impression that this is a protective measure to prevent the contiguous organs such as the small bowel, liver, spleen and kidneys from becoming affected by the disease.

Regardless of the severity of the ulcerative colitis and of its duration the ileum seldom becomes affected except occasionally a few inches near the ileocecal valve. This can be distinguished from terminal ileitis or ileocolitis for not only are several feet of the ileum affected but also the ascending and sometimes transverse colons as well and other portions of the small bowel.

MEDICAL VERSUS SURGICAL TREATMENT

Whether this disease should be treated medically or surgically has produced as much controversy as has the treatment of duod-

denal and gastric ulcers. It was our belief as early as 1914 and 1915 that medical treatment has very little value. If a patient is fortunate enough to have only a mild form of the disease a complete spontaneous cure may take place or he may have only mild recurrences from time to time. However if he has a severe type of infiltrative ulcerative colitis ulceration and complete destruction will occur in spite of whatever medical therapy is instituted. His only chance for relief of the disease is a preliminary ileostomy with removal of the colon.

Medical practitioners who have persisted in long continued treatment of these cases are many times treating a patient whose colon has been completely destroyed, from a physiological as well as anatomical standpoint and in which there is no mucosa left. The colon has become nothing more than a pus filled structure with multiple strictures. It is rather hard to conceive that diet, medicine, or antiseptic could affect such an organ so completely destroyed. Barger's vaccine therapy for this condition if it is to be effective must be used before the destruction of the colon has taken place. In such a colon as described above there is no possibility of repair that would be sufficient to permit it to perform in part its physiological functions. We have, therefore since 1917 and 1918 advocated early ileostomy as the only cure or possible chance for cure in this condition for it saves the colon from becoming destroyed to such an extent that the physiological functions of the organ would be impossible. Since 1923 and 1924 we have advocated that an ileostomy should be performed as soon as the diagnosis of ulcerative colitis is made.¹

That we may be performing ileostomies on patients who would have gotten well without surgical interference may be true but no one can deny that in such a case the ileostomy can always be closed, with no harm accruing to the patient. However if the colon has been destroyed by persistence in medical treatment then the ileostomy can only arrest the disease, for the destruction of the organ has already occurred. If an ileostomy is done as soon as the diagnosis of ulcerative colitis is made not only may we arrest the disease but we may save the patient's colon from being destroyed by the infection.

There is no more reason to question surgical interference in a case that is definitely diagnosed as ulcerative colitis than to hesitate to operate upon a patient for appendicitis under normal circumstances. Temporizing is not called for in either case. The

simple loop ileostomy after a diagnosis of ulcerative colitis is definitely established will save the patient's life and colon, while medical treatment can only result in the eventual destruction of the organ and death.

ADVANTAGES AND DISADVANTAGES OF ILEOSTOMY

The clinical relief that a patient obtains from an ileostomy is really remarkable. A patient who has been anemic with marked joint symptoms, bedridden, septic with a high temperature with tenderness or sometimes a rigid abdomen and who has lost more than one half his body weight will show a marked improvement within five to seven days. Within ten to fourteen days the joint symptoms, the bronchial infection and cough disappear, the temperature drops to normal and the abdomen becomes soft with no tenderness. The patient within a few weeks has the appearance of a person making a rapid recovery. The critical stage of the disease is weathered and improvement is such that later if necessary a colectomy can be performed either in one stage or by a sectional removal of the colon.

The benefits from ileostomy are due to several factors. By diverting the intestinal stream through the inflamed organ, peristalsis and cramps cease and the organ is put at rest. The colon contracts and the inflammatory process subsides. The various bacteria that normally are present in the colon disappear and in addition the colon can be irrigated by a through and through method to get rid of the pus accumulated in the flexures and in the pockets formed by the strictures. We have used acriflavine, hexylresorcinol and normal saline solutions for this purpose. We have come to the conclusion that a simple saline solution acts as well as the others and is less irritating to the bowel. We have also tried such substances as the various sulfa drugs repeatedly but our experience with them to date has not been extensive enough to justify any definite conclusions. We have seen no evidences of healing as a result of their use but possibly more time is needed to draw a fair estimate of their value.

Surgeons and physicians alike have in the past hesitated to advocate ileostomy for the patient with ulcerative colitis because of their belief that subsequently it will be difficult to keep up his nutritional and body weight. Our experience has shown this fear to be completely unfounded. Since 1915 we have not had a single instance in which we have not been able to keep up the nutritional balance of the patient following ileostomy.

for this condition. In fact, practically all our patients gained from 10 to 50 pounds, their stools became solid, especially if a heavy residue diet was used, and the infectious process in the colon subsided. There is no question that when an ileostomy is performed the colon immediately contracts and its physiological function of absorption of water disappears and is taken up by the ileum within ten to twenty-one days. This is shown when the liquid stools become solid.

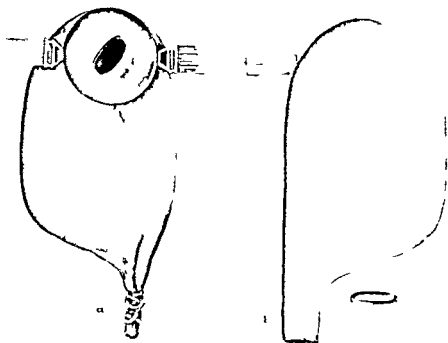


FIG. 4.—*a* The opening in the bag with the metal disk which is covered by rubber. The opening present is varied according to the size of the ileostomy, and the bag is available in different sizes. *b* Posterior portion of the bag illustrating its size and shape. *c* Actual size of the opening for the ileostomy. The bag fits tightly against the skin and is held there by a latex preparation which acts in the same manner as glue so that it remains adherent without the support of an elastic belt.

The second objection to ileostomy is the irritation of the skin produced by the intestinal contents. We have completely solved this with a bag devised by one of us (A. A. S.) and Mr. Koenig, a chemical student on whom we corrected an ileostomy done elsewhere and on whom we eventually performed a colectomy. At our suggestion he developed a bag which covers the ileostomy and does not permit secretions to come in contact with the skin. The bag is held to the skin with a latex preparation which we will describe later and completely prevents the irritation of

the skin as well as the possible escape of secretions collect them in light soft rubber container (Fig 42)

Another theoretical objection that the colon contracts and produces strictures after the establishment of an ileostomy is unwarranted. When an ileostomy is performed early in ulcerative colitis the deeper structures of the colon are not affected so that no strictures will occur. However if the ileostomy is performed in more advanced cases in which the deeper structures are already involved then the strictures have formed previously and will continue to form whether the ileostomy is present or not. By arresting the disease with the ileostomy there will be less stricture formation than without it.

Our experience with the simple loop type of ileostomy dates from 1914 and 1915 and we have used the same technic throughout this period. We have used it not only for ulcerative colitis but as a preliminary operation for resection of the colon for carcinoma in preference to the customary transverse colectomy or cecostomy for injuries to the colon from bullet and gunshot wounds for severe acute terminal ileitis and ileocolitis occasionally for a badly neglected strangulated intussusception and also as a method of decompression of an acute obstructed colon in preference to a cecostomy. Thus we have collected an extensive series which should be adequate for an evaluation of the procedure and for a comparison with transverse colectomy and cecostomy from the standpoint of results. We have not had the mortality or difficulties that other surgeons have described which we think is largely due to the simplicity of the type of ileostomy we do as compared to the more complicated type reported from other clinics as by Cattell of the Lahey Clinic Case³ of the Roosevelt Hospital New York and Garlock⁴ of Mount Sinai Hospital New York.

TECHNIC OF SIMPLE LOOP ILEOSTOMY

Our technic of ileostomy is as follows. If the patient is old feeble or debilitated the operation is done under local anesthesia. We usually use a McBurney gridiron incision a trifle more medianward than for an appendectomy so as to allow room to place the ileostomy bag (1 in Fig 43). After picking up the cecum the ileum is taken 4 or 5 inches from the ileocecal valve depending on the height of the abdomen the size and thickness of the abdominal wall and the amount of fat in the abdomen so that the loop will reach well out on top of the

abdominal wall without tension. Some allowance is made if the patient is relaxed under spinal or deep anesthesia for the traction that will occur after the anesthesia has subsided. A fine

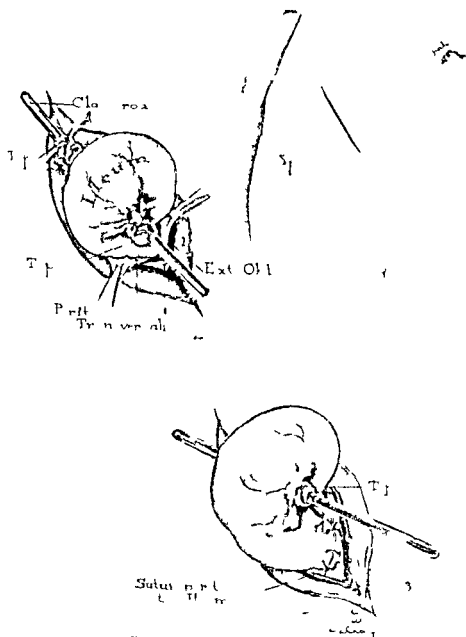


Fig 43-1 McBurney incision for ileostomy 2 Loop of ileum brought up through the incision with glass rod holding it in place 3 Peritoneal sutures to both loops of ileum

artery snap is passed through the mesentery just beneath the wall of the ileum which is opened and a glass rod passed through the slit in the mesentery (2 Fig 43). The glass rod is held in

method. A sinking in of the ileostomy is also rare but it has occurred occasionally in cases of permanent ileostomy because of the extreme thinness of the patient. In these cases we simply split the mesentery and pulled a small tongue of skin through the slit there to act as a bridge. In two instances where there was extreme prolapse in later years we made a separate small right rectus incision and transferred the proximal loop of the ileum retroperitoneally by splitting the parietal peritoneum and suturing it over the ileum thereby curbing the prolapse. These cases of prolapse occurred before the above described ileostomy bag was devised and we have not had one such case since we started to use this new bag.

We have had only two small eviscerations and one intra abdominal herniation in more than 500 ileostomies which have been done for various conditions. Our mortality has been extremely low from this procedure, death occurring in only four cases in which peritonitis resulted from perforation in ulcerative colitis.

RESECTION OF THE COLON

When an ileostomy is performed fairly early many patients get along without additional surgery and clinically are quite well for many years. We have had seven cases of simple ileostomy that we have followed since 1920 in all the patients have been quite normal clinically. On the other hand in some of the more severe cases in which ileostomy was done rather late the patients have improved to a certain point and then have had a recurrence of symptoms with temperature, bloody stools, mild joint complaints and so forth.

It is our opinion that patients who suffer a recurrence of symptoms after ileostomy should be colectomized preferably by sectional removal of the colon. Whether the patient should have a final complete colectomy or the colon removed down only to the rectosigmoid depends upon the clinical result and the condition of the patient after removal of each segment. We have seen quite a number of patients who have been perfectly well clinically after the removal of the colon in two steps up to the rectosigmoid and we decided that further surgery was not necessary. We have removed the rectosigmoid in only eleven cases. We have also seen in quite a number of instances a tremendous improvement in the condition of the patient after removal of the cecum, ascending and transverse colon. We feel that when a patient is ill and a poor surgical

risk it is best not to remove too large a section in the first stage for after removal of the first section up to the middle of the transverse colon the patient usually becomes a much better risk for surgery and then a more extensive resection can be done

Since 1927 we have not performed complete colectomy in one stage or even subtotal colectomy up to the rectosigmoid we have preferred instead to remove the colon in these cases in three stages going to the middle transverse colon in the first stage to the rectosigmoid in the second and finally removing the rectosigmoid in the third stage if necessary. We have not often removed the rectosigmoid portion of the colon for two reasons first the majority of our patients are usually so well that they do not care to have any further surgery done and secondly the short loop of the bowel drains itself in such a manner that there is little absorption from it consequently it can be kept clean by a through and through irrigation by the patient himself if needs be. Only if a rectovaginal or a rectal abscess forms in this area do we perform the final stage of rectosigmoid removal

ILEOTRANSVERSE COLOSTOMY AND ILEOSIGMOIDOSTOMY

In our opinion ileotransverse colostomy or ileosigmoidostomy has no place in the management of ulcerative colitis. Five patients operated upon elsewhere by these methods have come to us later with severe hemorrhages at the point of anastomosis. In three cases an ileotransverse colostomy and in two an ileosigmoidostomy had been done and we performed subtotal colectomy up to the rectosigmoid beyond the point of anastomosis as a life saving measure because the specimens showed that the hemorrhages had occurred at the point of anastomosis. We question very much whether there is a true segmental ulcerative colitis. While the specimens which we have examined show more pathologic change in one area than in the other a fact which can sometimes be demonstrated by x ray and sigmoidoscopic examination in the majority of cases the entire colon will be affected sooner or later. The infectious process will continue to progress by way of the submucosal and lymphatic channels of the bowel wall and also through the many glands in the mesentery. For this reason we do not believe that an ileotransverse colostomy or an ileosigmoidostomy or that saving the rectosigmoid portion with the idea of later

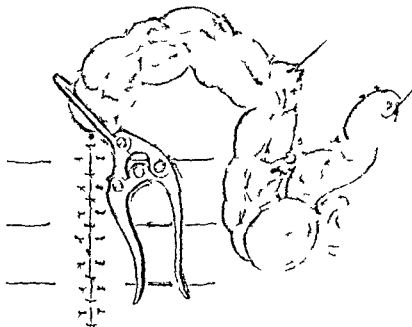


Fig 45 Abdominal incision below the ileum, cecum and clamped the abdomen just before amputation

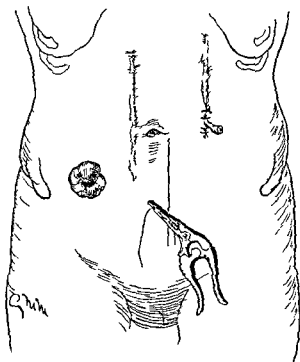


Fig 46—Final stage with ileostomy in place and distal part of sigmoid colon brought up through incision and held in place by a Payr clamp

doing an ileorectostomy or an ileosigmoid rectostomy is advisable. In three cases in which we attempted ileosigmoid rectostomy earlier in our experience, we had to undo the anastomosis and reconstruct the ileostomy. Although we do not believe in removing the rectosigmoid if the patient seems perfectly well and remove it only when an abscess or fistula has formed, we do not preserve it with the idea that later we will perform an ileosigmoid rectostomy.

Our series of cases is not large considering that we have been interested in this work since 1915 and have had only 104 cases in which we performed ileostomy, with four deaths. Forty of these patients had ileostomy only, forty nine had subtotal colectomy in a two stage operation with sectional removal of the colon, and eleven had complete colectomy in a two stage operation which resulted in two deaths. In our resection we do not try to peritonealize the parietal peritoneum of the ascending and descending flanks or try to free the portion of the omentum of the transverse colon. We also do not amputate the colon until the abdominal wound is closed as shown in Figures 45 and 46.

PREOPERATIVE AND POSTOPERATIVE TREATMENT

Very ill patients are often undertreated rather than over treated insofar as concerns the supportive measures of glucose saline blood and plasma. Patients who have received a large number of blood transfusions and unusually large quantities of glucose and plasma have done much better than those who were given just an ordinary amount. Parenthetically, when a patient is seriously ill we prefer the direct syringe cannula needle method of blood transfusion rather than the slower citrated method for we have found that patients recover more quickly and are better off generally following the former procedure.¹

These supportive measures have a pronounced effect on the mortality rate of colectomy. Especially is this true of the amount of glucose and saline supplied after the first three or four weeks following an ileostomy when the low water balance may be unnoticeable and the protein balance may sink far below normal without detection. The tendency is to give insufficient quantities of fluid intravenously rather than too much.

CONCLUSIONS AND SUMMARY

- 1 There are two clinical types of ulcerative colitis—the mild superficial type which affects only the mucosa and the severe

type which affects the entire thickness of the colonic wall as well as its lymphatic and mesenteric glands

2 A simple loop ileostomy should be performed in every case in which there has been a definite diagnosis of ulcerative colitis on the same principle that we perform an appendectomy for acute appendicitis even though the patient may recover without operation. This simple loop ileostomy may be easily closed if the colon should return to a normal condition.

3 Long continued medical treatment of ulcerative colitis usually results in complete destruction of the colon by the infective process. When persisted in it makes ineffective any subsequent surgical approach to the problem.

4 A colectomy should be done preferably in two stages up to the rectosigmoid following a preliminary ileostomy. The rectosigmoid need be removed only in cases in which there is fistula or abscess formation in the lower segment or if the patient's condition is not satisfactory clinically. We do not believe that an ileotransverse colostomy or an ileosigmoidostomy should be performed at any time during the course of this disease.

5 Subtotal colectomy in one stage is contraindicated. The simple loop ileostomy which we have described and performed since 1914 not only for ulcerative colitis but also as a preliminary operation for removing sections of the colon for other pathological conditions is most satisfactory. It will fulfill its purpose as well as the complete or divisional ileostomy advocated by other clinics.

6 The reported series of 104 cases from our clinic is not large when one considers that it extends over a period of twenty-eight years of work. The conclusions arrived at are simply the impressions gained from these years of observation. In a large number of other cases which we have seen with medical practitioners they have refused us permission to operate. This experience coincides with that of other clinics.

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SURGERY OF MALIGNANT TUMORS OF THE CARDIAC END OF THE STOMACH AND OF THE TERMINAL END OF THE ESOPHAGUS

JOHN M. DORSEY, M.D.

THE first successful resection of the esophagus for malignancy was performed by Torek in 1913. It was not until 1938 that according to Bird, Adams and Phemister did the first successful thoracic esophagogastrostomy in this country for carcinoma. Since that time there have been many advances made in the surgical approach to malignant tumors of the terminal esophagus and cardiac end of the stomach. It is the purpose of this paper to enter into the discussion of a number of these.

THE PATHOLOGY OF GASTRIC AND ESOPHAGEAL CARCINOMAS

Cancer of the stomach is largely of the glandular or the adenocarcinomatous type. It has long been recognized that the spread of such lesions to the adjacent lymph glands, the liver, the peritoneum and by gravity to the pelvis may occur before symptoms call attention to their presence. For this reason the operability of cancer of the stomach is about 25 per cent.

Malignant tumors of the esophagus on the other hand are usually of the squamous cell variety and as such are stenosing in character. Boyd states that about 20 per cent of cancers of the esophagus are nonstenosing, polypoid in nature. The symptoms of esophageal cancer are largely those due to disturbance of deglutition. This interference may not be marked until the complete circumference of the esophagus is involved with tumor. For this reason surgical aid is not sought until the lesion is of rather long standing. Squamous cell carcinoma of the esophagus tends to remain a local process in 25 to 40 per cent of patients so affected. Because symptoms are allowed to go uninvestigated in spite of the absence of regional or distant metastases the growth becomes so extensive locally that surgical removal is impossible. Because of this the operability of cancer of the esophagus remains in the neighborhood of 25 per cent.

It is obvious that the reasons for the low operability of malignant tumors of the stomach and of the esophagus are different.

the esophagus because of the extensiveness of local involvement the stomach because of the tendency to metastases before symptoms bring the patient to the surgeon

Pathology as Determining Surgical Approach

Despite the fact that tumors of the cardiac end of the stomach can most adequately be exposed and resected through the thorax it has been our policy to advise preliminary celiotomy because as we have said distant metastases make complete surgical eradication impossible. We feel that the presence of such metastases can be most readily determined through an upper abdominal incision large enough to admit the operator's hand. If such metastases are present further surgery is not advisable. If they are not demonstrable we immediately undertake transthoracic exploration. To do this primarily seems to us to be too radical in view of the known low operability of malignant tumors of the stomach.

On the other hand the slower to metastasize squamous cell cancers of the lower esophagus should be approached trans thoracically without preliminary celiotomy. It has been our experience that these tumors from the level of the bifurcation of the trachea downwards metastasize to the lymph glands in the gastrohepatic ligament and do so before they involve the adjacent lymph glands through the spread of malignant disease. For this reason it seems quite obvious to us that transthoracic surgery should be done through the left chest which allows for the exposure of the gastrohepatic region quite readily in all cancers that may be found as high as the level of the tracheal bifurcation or aortic arch. It is recognized that the right sided approach has certain anatomic advantages but these are outweighed by the more important factors concerning the removal of metastatic glands.

THE IMPORTANCE OF ESOPHAGOSCOPIC BIOPSY

Fluoroscopic visualization of the esophagus by means of barium along with esophagosopic visualization of the tumor are the most important means of diagnosis. It is absolutely essential that in all suspected cases of cancer of the esophagus a positive biopsy be obtained. The surgeon who contemplates transthoracic operation without this information at hand assumes more risk than is advisable. This presupposes of course that expert esophagoscopic talent is at hand. We have explored esophageal

lesions which we were positive were carcinomas without previously obtaining malignant tissue by biopsy. Recently however we have had an experience which makes us feel that this has been unwise.

A fifty year old man was referred to the Presbyterian Hospital with a history of dysphagia of three months duration. X ray examination of the esophagus after ingestion of barium revealed a typical stenosing lesion with obstruction in the terminal esophagus. Esoph



Fig 47 -X ray showing filling defect in the fundus of the stomach diagnosed as gastric cancer

agoscopy was advised. An ulcerating lesion which bled easily was observed at 38 cm from the incisor teeth. A piece of this tissue was removed with a biting forceps and sent to the laboratory for examination. It was reported as being inflammatory. The examination was repeated in one week's time and again the report was inflammatory tissue. The esophagoscopist was sure in his own mind that the lesion he saw was cancer and surgical exploration was contemplated. However further esophagoscopy was sought and on a third examination an obstructing bolus of meat was removed from the



Fig. 48—Esophago peritoneal mesothelioma. This is a squamous cell carcinoma, probably of esophageal origin.

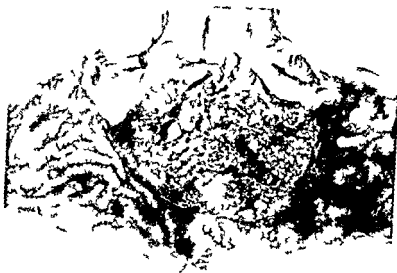


Fig. 49—Squamous mesothelioma. This is a squamous cell carcinoma, probably of esophageal origin.

terminal esophagus. The symptoms of dysphagia disappeared and careful follow up studies disclosed no evidence of tumor distal to the region of obstruction.

Figure 47 is the reproduction of an x ray film demonstrating a deformity in the cardiac end of the stomach and lower esophagus diagnosed as a carcinoma arising in the fundus of the stomach. Examination and biopsy by means of the esophagoscope revealed the tissue to be of the squamous cell variety as illustrated in Figure 48. According to the principles previously stated this squamous cell tumor presumably arose in the esophagus instead of in the stomach as diagnosed by x ray. For this reason primary transthoracic exploration was carried out and esophagogastrostomy performed. Figure 49 represents the gross specimen removed surgically. It is impossible to tell from the appearance of this specimen whether it arose from the stomach or esophagus but the microscopic nature of the tumor is presumptive of its esophageal origin. There were no metastases found at the time of surgery. The patient died on the fourth postoperative day of pneumonia. There was no leakage at the line of anastomosis. There was no evidence of carcinoma remaining on careful postmortem study.

PREOPERATIVE PREPARATION

Patients who have suffered from dysphagia with its attendant malnutrition as evidenced by weight loss and anemia are not good candidates for extensive surgical procedures. At the same time when cancer is present it is to the patient's advantage to have the cancer resected at the earliest possible moment if preliminary surgical procedures can be safely omitted. In lesions of the cardiac end of the stomach and lower esophagus we feel that primary operation for removal of the tumor may be contemplated if proper preoperative preparation is carried out. When a tumor of the esophagus is so located that it is high enough so that gastrostomy must be performed as a necessary part of the surgical procedure then of course this must be done at once and so serves the twofold purpose of determining operability at least in part and of allowing for resumption of adequate nutrition.

When a patient suffering from malignant disease of the lower esophagus and cardiac end of the stomach is first admitted to the hospital measures to combat dehydration are immediately instituted. Blood may be given by vein if the anemia is sufficient to warrant it. Vitamin determinations are made and parenteral vitamins administered. The oral cavity is cleansed to a maximum degree. We then recommend that at least 1500 cc. of blood be

areolar tissue. The extent of the tumor upward may be readily determined at this point.

By following the esophagus to the hiatus in the diaphragm the diaphragm may be opened radially to expose the fundic end of the stomach, the region of the spleen, pancreas and gastro-hepatic ligaments. This wide exposure readily allows for the

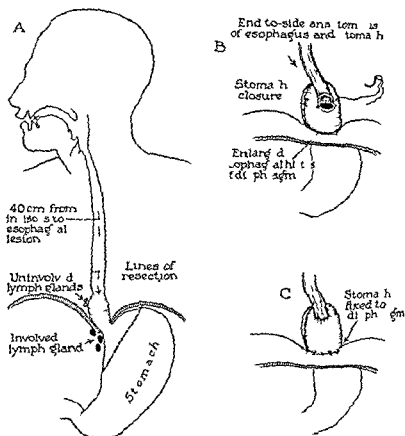


Fig. 53.—A Schematic illustration of the tumor seen in Figure 51. It was 40 cm. from the stomach. The involved lymph glands were not involved in cancer. Those with gastroepiploic ligament were. B End-to-side esophagogastric anastomosis. A running suture is correctly illustrated. C Anastomosis completed. The stomach is fixed to edges of diaphragm.

determination of operability. If resection is possible the phrenic nerve is crushed to eliminate motion of the left diaphragm. The left gastric vessels are divided as well as those at the greater curvature of the stomach. If necessary the spleen may be removed. The stomach may be resected as far down as the duodenum which may be closed as in resections of the stomach.

done through the abdomen. If this is the case the jejunum may be used for esophageal anastomosis as has recently been described by Sweet. Otherwise the portion of the stomach remaining may be readily brought into the lower thorax and an end to side anastomosis performed with interrupted silk sutures as illustrated in Figure 53. It will be noted that there is produced a diaphragmatic hernia (Fig. 53, B). In our experience this has not given rise to serious symptomatology. We advocate end to side rather than various types of pull through anastomoses because the likelihood of stricture is not so great.



Fig. 54—Postoperative (six months) barium visualization of esophagogastric anastomosis. There is no stricture.

Sulfanilamide is placed in the region of the resection in the upper abdomen as well as in the lower chest. The stomach above the diaphragm is sutured to the edges of the diaphragm (Fig. 53, C) so as to prevent herniation of viscera into the chest. A de Pezzer catheter is led to the outside from within the left lower chest. Negative pressure operating through this catheter aids in the re-expansion of the left lung postoperatively. The wound is closed in layers and the patient is placed in an oxygen tent.

The following case history illustrates the successful treatment of a carcinoma of the terminal esophagus as described above.

Mr A S a fifty four year old man was admitted to the Presbyterian Hospital on February 10 1942 He complained of difficulty in swallowing over a period of three months and a weight loss of 20 pounds He had a sense of fullness under the sternum coming on immediately after eating which was followed by vomiting particularly in recent weeks His hemoglobin was 14 gm red blood count 4 100 000 and the white blood count 8000 The Kahn reaction was negative After several esophagoscopic examinations tissue diagnosed as epidermoid carcinoma was obtained Immediate operation was planned and several blood donors who were compatible were used to obtain 1500 cc of blood

Figure 50 illustrates the appearance of the lower esophagus after ingestion of barium showing the complete obstruction in its terminal portion Figure 51 is a photomicrograph of tissue removed for biopsy through the esophagoscope This is a squamous cell type of cancer Figure 52 is the resected surgical specimen that was removed according to the procedure described above Figure 53 A is a line drawing illustrating the interesting fact that lymph glands adjacent to the tumor were not involved by carcinoma cells but that the more distant lymph glands in the gastrohepatic ligament did contain metastatic cancer cells Figure 54 is a barium study of the anastomosis made several months postoperative The new opening is widely patent and there was no dysphagia at any time

DIFFERENTIAL DIAGNOSIS

It is important that lesions resembling carcinoma be recognized by careful study Whereas there are perhaps numerous conditions of this kind two have come to our attention which are difficult to distinguish from malignant lesions

Mrs E A entered the Presbyterian Hospital in January 1940 with a complaint of dysphagia of two years duration becoming much more marked within the last six months Figure 55 is that of an x ray of the lower esophagus and stomach showing a deformity suspected of being an early cancer The esophagoscopic biopsy did not reveal the presence of malignant tissue but was that of a benign ulcer as illustrated in Figure 56

Ulcers of the terminal esophagus are perhaps more frequent than is commonly recognized They are very often associated with peptic ulceration of the stomach Occasionally they go on to produce stenosis by scar tissue contracture sufficient to necessitate esophagogastrostomy This however is not the usual course of events They respond more often to medical management



Fig 53.—Constrictive deformity of lower esophagus, suspected of being an early carcinoma.



Fig 54.—Photomicrograph of esophageal biopsy of Figure 53. This is a benign ulcer.



Fig 57 - Luminal dilatation of stomach in case of pyloric stenosis. This proved to be a small, localized, and small diaphragmatic hernia.



Fig 58 - Esophagoscopic biopsy of pharynx of Figure 57. Normal gastric glands.

The following case illustrates another condition which can be readily confused with cancer of the lower esophagus

Mrs E H, a sixty eight year old woman entered the Presbyterian Hospital in 1937 complaining of dysphagia Figure 57 illustrates the x ray of her lower esophagus Figure 58 is a photomicrograph of the tissue removed through the esophagus showing the glandular character of the tissue This was at first interpreted as being a carcinoma arising from mucous glands in the lower esophagus However, time has proved that this patient is suffering from a small *diaphragmatic hernia* There is a pouch of stomach above the diaphragm as can be seen in Figure 57 It is from this region that biopsy was taken and instead of being a glandular type of carcinoma the tissue is that of normal gastric glands

In conclusion it may be stated that in order that successful surgery of lesions of the lower esophagus and cardiac end of the stomach may be carried out, careful attention must be given to the many points in diagnosis differential diagnosis and treatment that have been suggested

SUCCINYLSULFATHIAZOLE (SULFASUXIDINE) AND THE ELIMINATION OF THE MIKULICZ OPERATION*

MOSES BEHREND MD F.A.C.S†

With the gradual refinement in the production of the sulfa products from the original prontosil we have in succinylsulfathiazole (sulfasuxidine) one of the outstanding bactericidal agents. At the last meeting of the American Medical Association held in Atlantic City in 1942 Dr E J Poth proposed the use of this drug in the preparation of patients prior to operations upon the colon. Favorable statements made then have been supported in actual practice.

SUCCINYLSULFATHIAZOLE IN THE PREPARATION OF THE PATIENT

The patient is prepared in the following manner. An ounce of castor oil is given soon after his admission to the hospital. Absolutely no solid food is given after that time. No operation is performed on the colon unless the patient has received at least a week's preparatory treatment. Succinylsulfathiazole is given in the dosage of 0.5 gm. to a kilogram of body weight. One half of the total dose for the day is given primarily, then as much as 4 to 6 gm. to a dose may be given every three or four hours for one week. Two colonic irrigations are given daily. Five hundred cubic centimeters of 5 per cent glucose in saline or distilled water is administered intravenously. Required transfusions are given but routinely 250 to 300 cc. of blood is prescribed the day before operation. The patient is allowed sweetened liquids of all kinds including orange juice, grape juice, all soft drinks and gelatine every two hours. Curiously enough he rarely craves for other foods.

Much of the success of the operation will depend upon the attention to every detail in the preoperative preparation of the patient. Poth claims that it is not necessary to use any purgation or cleansing enemas while using succinylsulfathiazole. He states that the patient may be prepared at home until the time of his admission to the hospital for operation. Poth and Knotts state

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that the drug given in therapeutic doses alters the feces because they become semifluid and practically odorless. The coliform organisms are reduced to such low values that *B. coli* cannot be demonstrated by growth on desoxycholate plates.

MIKULICZ OPERATION

Whenever the Mikulicz operation is performed several steps at different intervals are required before absolute healing and the normal passageway of feces is again established. The Mikulicz operation is always an annoying procedure because before complete healing takes place the soiling with feces of the abdominal wound after the clamps are removed is disagreeable both to the patient and surgeon. The early method of placing clamps and allowing the tumor to remain in situ outside the abdomen was succeeded by the very desirable refinement of removing the tumor at the primary operation. The clamps were removed within forty eight hours followed by the placing of a crushing instrument in the double barreled colostomy so that the passage way for feces might be reestablished. The bed occupancy of these patients was formerly from six to ten weeks although many elected to return home between the various stages.

IMPROVED TECHNIC WITH SUCCINYLSULFATHIAZOLE END TO END ANASTOMOSIS

As a result of the preparation of the patient with succinyl sulfathiazole parenteral feeding and the diet as outlined above the colon is practically empty at the time of operation. A transfusion of 500 cc of blood is given in the operating room. Whenever possible instead of using the several stage Mikulicz operation I now perform an end to end anastomosis immediately after the removal of the growth. The latter is a safe procedure. The so called 'aseptic' method of performing an intestinal anastomosis is not absolutely necessary. Particular attention is paid to the linen thread sutches in the mesocolon and the posterior wall of the colon. Interrupted mattress sutures of catgut are placed through the gut and the knots are tied within its lumen. A separate running suture of catgut apposes the adjacent free edges of the intestine. At least three layers of suture are applied posteriorly. The lateral and anterior portions of the anastomosis are sewn with catgut by means of the Connell suture. The final stitch is an interrupted or continuous linen thread suture. No cecostomy is required nor is the use of a de Pezzer catheter as a safety valve a necessary precaution.

Succinylsulfathiazole is continued for four or five days following operation. Nothing is given by mouth for at least three or four days when liquids are started consisting of the same intake as in the preoperative treatment. Five per cent glucose and blood transfusions are given immediately after operation. During twenty four hours no more than 3000 cc is given unless the case demands it. The day following operation a blood transfusion of 300 to 500 cc is given and repeated as often as necessary. Prostigmine is prescribed twice the day before operation and repeated at 7 A.M. on the morning of operation.

PRESENTATION OF CASES

CASE I—E. F. a woman aged sixty six years was admitted on August 30 1943 and discharged October 11 1943. In July 1943 she noticed bleeding from rectum of one week's duration. Digital examination was negative. Proctoscopic examination showed two polypoid growths in the rectum about 8 inches from the anus which were removed. Histological study showed the growths to be adenocarcinomas. Bleeding ceased for two weeks when it started again. There was no pain on defecation.

Physical Examination. The patient was apparently comfortable but had many mild complaints. She weighed 148 pounds. No abnormalities were disclosed. There was no tenderness and no masses were felt on abdominal examination. Vaginal examination revealed tenderness of the vaginal vault; the rectovaginal septum was negative.

Laboratory Report. The urine was light amber acid with a specific gravity of 1.014. It contained a faint trace of albumin, no sugar, no acetone, 14 to 18 white blood cells. Hemoglobin 11.6 gm. (80 per cent). White blood cells 8100. Blood sugar 86. blood urea nitrogen 10.1. Preparation of the patient for operation was started September 1 1943 in the manner outlined previously.

Operation. On September 10 1943 under continuous spinal anesthesia reinforced by nitrous oxide and ether the abdomen was opened by a left rectus incision. A napkin ring type of carcinoma of the sigmoid was found. After this portion of the intestine was mobilized Stone clamps were used and the intestine incised between the clamps. An end to end anastomosis was made with three layers posteriorly and two layers anteriorly. Number 0 chromic gut reinforced with linen thread was used. Tabs of fat were anchored over the anastomosis. Sulfanilamide was sprinkled on the wound and in the peritoneal cavity. As a precautionary measure in case of leakage a piece of soft rubber tissue is always placed adjacent to the anastomosis. The wound was closed with interrupted dermal sutures, No. 2 chromic catgut and clips.

Pathological Report. Macroscopic. The specimen is a resected

portion of colon with mesentery attached which has already been opened through its length. In its restored state it measures 14 by 6 cm. At one end there is present a large sessile mass measuring 4.5 by 3.5 cm. It does not completely replace the entire circumference of the colon but appears to occlude the lumen. However, it invades the entire thickness of the wall. Its inner surface is purplish brown and relatively smooth. Its edges are almost distinct from the surrounding normal mucosa. On sectioning it is firm purplish gray and at various levels is seen to involve progressively various depths of the colonic wall. The remainder of the mucosa appears normal. The lumen of the colon distal to the growth is narrowed to a circumference of 3.5 cm, whereas the lumen proximal to the growth measures 5.5 cm in diameter. The appended fat contains several slightly enlarged lymph nodes, some of which appear involved by the malignant process. Most of these glands are contained in the tissue immediately surrounding the growth.

Microscopic—The carcinomatous process involves the entire thickness of the colonic wall in some regions. The lymph nodes sectioned show no infiltration.

Pathological Diagnosis—Primary obstructing adenocarcinoma involving entire thickness of wall of sigmoid flexure.

Comment—Here is presented a typical case in which formerly a Mikulicz two or three stage operation would have been performed. Instead of remaining eight to ten weeks in the hospital this patient could have been discharged in two weeks following the operation but elected to stay another week. There was absolutely no infection of any kind in this case. The wound healed by first intention. For ten days before operation and five days following operation the diet consisted of fruit juices, sweetened liquids and gelatine only, after which pap foods, minced vegetables and meat were gradually added to the diet. Particular attention should be given to the fact that in this case succinyl sulfathiazole was administered in dosage of 0.5 gm. to a kilogram of body weight. There were no complications as a result of the administration of the large doses of this sulfonamide drug.

CASE II—H. C., a man aged sixty-seven, was admitted on August 31, 1943, and discharged September 25, 1943. His chief complaint was increasing constipation. He had been well until six months previously when he noticed that he was becoming constipated. He took laxatives without satisfactory results. Two weeks before admission he had a period of five days without a bowel movement. For several years he had noticed bloody stools occasionally. His family history was unimportant.

Physical Examination The patient is a thin white somewhat emaciated male. His heart apparently is not enlarged; its rate and rhythm are regular. The lungs are clear to percussion; an occasional rale is heard on the right side at the base. The abdomen shows relaxation of the abdominal musculature. No apparent mass is felt. Liver and spleen are not palpable. Rectal examination reveals no mass in the rectum. Prostate is enlarged. The usual preoperative preparation as outlined previously was given.

X ray examination revealed the following. On the first attempt it was possible to fill only the rectum and a portion of the sigmoid. The patient was unable to retain the opaque medium and was allowed to expel it. After an hour's rest another attempt was made to give a colonic enema and at this time the opaque medium was shown to traverse the colon back to the region of the proximal transverse colon, where there was an abrupt cessation of flow. The colon became quite distended and haustral markings were not present. The patient complained bitterly and was unable to retain any more of the opaque medium. Films were made at this time and they confirmed the fluoroscopic study that the opaque medium traversed the colon back to the region of the proximal transverse colon where there was an abrupt stoppage, none of it being seen in the ascending colon. It was thought that this confirmed the previous suspicion that there was probably an annular lesion at this point. In all the films made there was also a filling defect in the colon near the junction of the descending colon and sigmoid. It was surmised that a malignant lesion was present in the sigmoid. I question this as the cause of the filling defect. Rather it suggested the possibility of either an annular lesion or a polyp at this area. This lesion may have been functional in origin but owing to its persistence it was felt that it must be regarded as an organic lesion until proved otherwise.

Laboratory Report Urine acid specific gravity 1.005; no albumin; no sugar; occasional white blood cells; occasional white epithelium. Hemoglobin 75 per cent; red blood cells 3,950,000; white blood cells 6000. Blood Wassermann test negative. Blood sugar 75 mg; urea 12 mg.

Operation was performed under continuous spinal anesthesia on September 4, 1943. With the patient under continuous spinal anesthesia and in the Trendelenburg position a left lower pararectus incision was made and the peritoneum was opened. Carcinoma of the transverse and descending colon was found. The liver was free of any metastasis and there was only small involvement of the regional nodes around the area of the descending colon. The rectum was free of carcinoma. A resection of the transverse colon, splenic flexure and descending colon was performed. An end to end anastomosis was then made between the ascending colon and sigmoid. There was no spillage and very little bleeding. Wide excision of both lesions was

possible because of the redundancy of the intestine. Eight grams of sulfanilamide was placed in the region of the anastomosis and one rubber tissue drain was inserted. The wound was closed with interrupted dermal retention sutures. The patient left the operating room in good condition.

Pathological Report Macroscopy. Specimen consists of a portion of the large bowel measuring 55 cm. in length. Near each end there is a deep malignant ulcer each measuring 3 cm. in diameter. On cut section the tissue is grayish white, opaque and firm. The malignant process extends down to serosa. The intervening bowel is normal except for numerous small polyps. No glands are seen.

Microscopy. Section of sigmoid shows a number of glands of Lieberkuhn as well as numerous abnormal epithelial cells having a papillary arrangement. The glands are lined by multiple layers of abnormal epithelial cells the chromatin of which is stippled. There is some dissimilarity in size and shape of nuclei and cells. Many of the nuclei are vacuolated. There is infiltration into the submucosa and muscularis.

Diagnosis Papillary carcinoma of sigmoid (Grade II). Section of transverse colon shows a number of polyps projecting from the mucous membrane. A number of foci and malignant degeneration are noted. There is very little invasive tendency.

Diagnosis Polyp of transverse colon showing early malignant degeneration.

Comment—This was a case of multiple carcinomas of the colon, and is another instance of an operation for carcinoma of the colon in one stage where formerly a simultaneous Mikulicz operation on multiple lesions of the colon was performed. Again preparation of the patient with succinylsulfathiazole enabled us to simplify this operation to a considerable degree. Before the introduction of this drug a double barreled colostomy remained which was annoying to the physician and patient both. Slight infection of the wound occurred twelve days following operation, but cleared up quickly.

CASE III—M. K., a woman aged sixty six years was admitted on October 19, 1943 and discharged November 20, 1943. Previously she had been admitted in October 1939 when a diagnosis of carcinoma of the rectosigmoid junction was made. She had then complained of pain in the abdomen and gradual loss of physical strength. Bowel movements were becoming more constipated. X-ray by means of barium enema confirmed the diagnosis. On October 5, 1939 a cecostomy was performed because of symptoms of intestinal obstruction. This was followed by a Mikulicz operation at the site of the lesion in the rectosigmoid area. The colostomy was closed

on November 24 and the patient was discharged December 30 1939

Pathological Report Ulcerating mucinous carcinoma Grades II and III penetrating all coats of the rectosigmoid area and extending into the mesenteric fat

Second Admission The patient was readmitted on October 19 1943 complaining of weakness again with inability to perform any kind of housework. She had lost some weight although there was no visible anemia. Abdominal examination revealed a large globular mass in the left iliac fossa. The mass was somewhat tender but it was freely movable under the abdominal wall. After admittance she was given the preoperative treatment outlined previously.

Laboratory Report Hemoglobin 13.10 gm (97 per cent) white blood cells 10,700 blood sugar 85 mg blood urea nitrogen 11.1 m

Operation consisted of excision of the tumor which affected the descending colon the rectosigmoid junction and some of the mesentery. The mass was round and measured about 3 inches in diameter. An end to end anastomosis between the transverse colon and the rectum was performed. Plasma (250 cc) was given following the operation. During the convalescent period there were no untoward symptoms with the exception of an infected wound at the lower angle of the incision.

Comment—As stated in the history this patient was operated upon four years ago for carcinoma at the rectosigmoid junction by means of a primary cecostomy followed by a Miles operation. She remained in the hospital nearly twelve weeks following this procedure. However after a week's preparation before her recent admission in October 1943 we completed a one stage operation an end to end anastomosis of the transverse colon to the rectum. She was discharged one month after admission. As a matter of fact she chose to stay ten days longer than was required for her immediate convalescence.

It is interesting to note that the pathologist believes that the mass recently removed is also a primary adenocarcinoma of the colon. For comparison I am including the pathological reports of 1939 and 1943.

Pathological Report (October 20 1939) Macroscopic The specimen is a portion of rectosigmoid measuring 10 cm in length. One centimeter from one of the lines of excision and 4.5 cm from the other is an annular malignant process measuring 6 cm in width and 4 cm in length which has apparently penetrated the entire thickness of the bowel in this region. The neoplasm projects in some regions into the lumen and has apparently resulted in partial obstruction.

tion In one region it is cauliflower in character and shows here surface ulceration It is advancing as a slightly elevated soft process definitely but not strikingly distinct from the surrounding tissue The serosa overlying the tumor is puckered No lymph nodes are palpable except in one outlying mesenteric region where a small nodule is felt The bowel on one side of the tumor measures 1 cm in circumference and on the other > 5 cm

Microscopic The nodule felt in the mesentery is a neoplastic extension.

Pathological Diagnosis Primary mucinous ulcerating carcinoma Grades II and III penetrating all the coats of the rectosigmoid and extending into mesenteric fat

Pathological Report (October 22 1943) **Macroscopic** The specimen is a large piece of colon measuring 43 cm in length At one end for a distance of 12 cm there is a large mass measuring 13 cm in diameter The peritoneal surface over this mass is markedly congested and contains an occasional small grayish white firm nodule On section this mass almost completely obstructs the lumen and distorts it The mucosal surface is purplish pink markedly ulcerated and contains many polypoid projections The mass on section presents a greenish gray and hemorrhagic appearance solidly honey-combed with mucoid material It is soft and friable and invades the entire intestinal wall In areas mucoid material has formed small cysts some of which are surrounded by hard calcareous material The uninvolved colon measures 3.5 cm in diameter and the line of demarcation between the carcinoma and the uninvolved colon is fairly sharp The uninvolved colon is filled with thick purplish red bloody liquid Its mucosa and wall appear essentially normal One portion of its peritoneal surface is roughened and thickened This area was attached to the peritoneum overlying the carcinoma There are several enlarged hemorrhagic lymph nodes present in the fat surrounding the mass In one area of the peritoneum overlying the mass there is a large perforation measuring 2.5 cm in diameter which appears to be preoperative

Microscopic A mucinous adenocarcinoma involves all the coats of the bowel and involving serosa The lymph nodes sectioned show no secondary involvement

Pathological Diagnosis Primary obstructive ulcerating mucinous adenocarcinoma involving all the coats of the large bowel

Comment—This case is interesting on account of successive lesions one of which was removed in 1939 the other in 1943 Symptoms of intestinal obstruction were present in 1939 A cecostomy was the primary operation followed later by a Mikulicz procedure performed in stages The patient remained in the hospital nearly twelve weeks In 1943 a huge mass invol

ing the rectosigmoid junction was removed. An end-to-end anastomosis was performed in one stage. She was discharged in four weeks. The specimens removed are interesting because the pathologist believes that both lesions were primary in origin.

CASE IV—E. K. a woman aged forty eight years was admitted on October 28, 1943 and discharged December 1, 1943. Diarrhea had been present for seven months. For the preceding two weeks she had had three or four loose watery bowel movements after each meal. In nine months she lost 30 pounds in weight. She had never been constipated nor had blood in the stools. She had occasionally noticed a mass in the right lower quadrant. Familial history was unimportant.

Examination of the Abdomen. A palpable tubular movable mass was felt in the right lower quadrant.

On October 30 the patient began a course of intravenous glucose and succinylsulfathiazole in preparation for operation. This was continued up to the time of operation.

Operation. At operation on November 6, 1943, under continuous spinal anesthesia, an end-to-end anastomosis was made between the descending colon and sigmoid. Two Penrose drains without gauze and 10 gm. of sulfanilamide were placed near the anastomosis. During the operation there was an expulsion of considerable feces from the proximal end of the colon. While there was no massive soiling of the peritoneal cavity because of protecting sponges around the field of operation, one could not call it an absolutely clean operation. Notwithstanding this contamination there was no sign of peritonitis. The patient developed an infection of the wound at its lower angle. Irrigation of this portion of the wound with Carrel Dakin solution cleared the infection quickly.

Pathological Report. **Macroscopy.** The specimen consists of a resected sigmoid measuring approximately 12 cm. in its long diameter. Approximately one half of the specimen is infiltrated with a fairly dense white mass which encroaches upon the lumen of the gut.

Microscopy. Section of tissue shows a number of glands lined by deeply staining neoplastic tumor cells. The nuclear chromatin is stippled. There is beginning invasion into the stroma. Numerous fibroblasts are present in the interglandular areas.

Diagnosis. Adenocarcinoma of sigmoid. Grade II.

Comment.—This case illustrates better than the previous histories the efficacy of large doses of succinylsulfathiazole before operation. Ordinarily this patient should have died of peritonitis as a result of the contamination of the peritoneal cavity with feces. No such complication resulted. The patient was discharged twenty five days after operation.

General Comment

With the analysis of the cases here presented it must be evident that with the use of this sulfur product surgery of the colon has been revolutionized. Provided the preparation as here outlined is given I am sure that now the colon may be operated upon with impunity and a primary anastomosis performed if the occasion demands it. Since we have been following this technic we have not used a preliminary cecostomy or a de Pezzer catheter as a safety valve.

CONCLUSIONS

1 The use of succinylsulfathiazole has revolutionized surgical procedures performed on the colon. The drug should be administered in large doses at least a week before operation and for five days after operation.

2 As a result the Mikulicz operation has been replaced by a one stage end to end anastomosis.

3 Four cases without a death are presented. The operative wound of the first patient operated on by the technic described healed by first intention; the last three patients developed infected wounds.

4 One patient had multiple lesions of the colon while another developed lesions four years after a Mikulicz operation.

5 The success of all colon surgery depends on the preoperative and postoperative care of the patient. This includes a primary purge, liquid diet, colonic irrigations, parenteral fluids including glucose, amino acids, plasma and blood transfusions.

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SYMPOSIUM ON REPARATIVE SURGERY

FILM CEMENTED SKIN GRAFTS

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EXCISION AND HANDLING OF SPLIT THICKNESS GRAFTS

The well known method of causing two surfaces to adhere after applying rubber cement to each surface was first used in plastic surgery by Padgett in 1937¹ for cutting skin for grafts. This procedure was an outstanding contribution to the technic of plastic surgery and has revolutionized the excision of sheets of free skin grafts. The excision of these grafts of uniform and predetermined thickness has been made so easy that today the average surgeon can readily cover large denuded surfaces of the body with skin by means of this technic. Moreover, it has greatly increased the number of available donor sites on the body by making possible the removal of split thickness skin grafts from areas of the trunk and extremities which were previously unsatisfactory for the free hand cutting of large grafts with a bare knife because of inability to obtain broad flat surfaces on these areas.

The dermatome devised by Padgett and Hood for this procedure is generally known to the profession and needs no description, being widely used by both civilian and military surgeons. Modifications of this instrument have been evolved by Lt. George V. Webster³ formerly of this clinic and recently by Caltagirone⁴. Each of these depends upon rubber cement for adhesion between the instrument and the skin of the donor sites.

Difficulties in Conventional Methods—While the removal of split-thickness skin grafts is greatly facilitated by the Padgett dermatome, a certain amount of experience and skill is required of the operator.

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in its use owing to difficulties that arise not only during the removal of the graft from the donor site but also when the graft is taken from the dermatome drum and applied to the recipient area.

The usual method for removal of the graft from the drum which is that employed by Padgett is to pull the graft free between two pairs of hemostats that clamp the ends of the graft at the corners. Immediately upon release the graft shrinks markedly from its original size through its innate tendency to contract—a tendency increased by the elastic rubber film usually adherent to the epithelial surface. If the coated surface of the graft folds or rolls on itself it becomes adherent and there is trouble in unfolding it. The graft therefore must be held flat stretched taut by the hemostats. This is especially ticklish when turning the graft over after removal from the drum and while adjusting it to the recipient area. With care the handling of the graft can be readily accomplished by trained operators and assistants if the graft is of sufficient thickness (.014 inch or more) to withstand the pull made on it by the hemostats. Thinner grafts (.012 inch or less) are often torn by the hemostats or in the process of suturing causing the sheet of graft to collapse and become adherent to itself. Time is lost and portions of the graft may be ruined during the straightening process.

There is another occasion during which the problem arises of preventing adhesion of the grafts to themselves when with a contaminated recipient area infection of the donor areas is to be avoided by first removing the grafts from the clean donor sites before affixing them. The grafts may then be stored upon layers of gauze moistened by normal saline solution and stretched out by the weight of the hemostats left attached to the corners. With this technic however adhesion of the cement covered surfaces is liable to occur.

Another method for removing these grafts from the drum and storing them temporarily is to start rolling the grafts from one end of the dermatome onto long moist gauze compresses. They can then be left at one side until required. However with this method the edges of the graft also tend to turn in and become adherent.

Improvements in Technic—Long before the value of large skin grafts was generally appreciated in other clinics John Stuge Davis⁶ and other members of William S. Halsted's staff were accustomed to cut tremendously large grafts by the free hand method from the medial and lateral femoral regions. Prior to affixing these grafts it was customary to spread them out epithelial surfaces down on thin sheets of gutta percha or so called protective tissue. When being applied each graft together with the overlapping tissue was lifted and placed in position to facilitate the application of the graft. The tissue was then removed leaving the graft in place. Davis reports that this was first done March 7, 1896. That method has been followed in this clinic with grafts cut by free hand.

With grafts cut by the dermatome it was our practice until recently at the time of removing the grafts from the drum to cover the raw surface of each graft as it lay cemented on the upturned drum with a transparent overlapping film of phiofilm. The graft together with its covering film was then pulled loose. The freed epithelial surface of the graft with any rubber cement that might still be adherent to it, was covered with another overlapping transparent film and the first film was removed. The process would be repeated after the cutting of each subsequent graft.

Dr S Baron Hardy resident in this clinic suggested a simpler technic (Fig 59). After raising one end of the graft from the drum

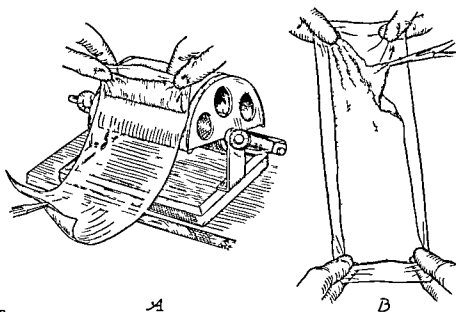


Fig 59—A method of removing a skin graft as ordinarily cut on the dermatome with the aid of a transparent film. Hardy's modification simplifying the usual procedure.

A End of graft is lifted from the drum and a piece of film is placed on the epithelial surface. The two are pulled away together.

B As the graft is not cemented to the film in this procedure adjustment is required to keep it stretched flat.

and applying an overlapping sheet of phiofilm or cellophane to the epithelial surface the two were raised and pulled away together leaving the graft on the film with its cut surface exposed. Successive layers of film and graft could be laid upon additional layers of moistened gauze compresses until needed.

This method of removal eliminated one stage in our usual procedure yet had certain drawbacks. The graft not being adherent to the transparent film contracted somewhat and occasionally curled back and stuck to itself.

It occurred to me that if the graft at the time of excision with the dermatome were stuck with rubber cement to a transparent film which

was adherent to the drum handling might be facilitated by preventing its rolling back and becoming adherent to itself. There might also be an advantage in ease of application to the defect of the combined sheets of graft and film immobilization on the defect with or without suturing of the graft might be obtained with greater ease and more over since the graft would continue in the state of tension that it had before its removal from the donor site it should take more readily. The advisability of maintaining this normal tension of the graft was stressed by Davis and Traut⁷ in 1925 and two years later by Davis⁸ when he said "We also found that the contraction of the elastic fibers in the skin occluded the vessels and for that reason when securing the graft in position we apply tension equal to that of the normal skin to overcome this tendency."

Transparency of the film would enable one to see the graft and recipient area while fixing the graft in position. It would also give the advantage of allowing observation of the graft during healing.

THE FILM

Whatever transparent film is selected should possess several characteristics. Obviously it should be of such a nature that rubber cement if used as an adhesive would cause the film and graft to adhere satisfactorily. It should also be of such thickness as to withstand the tendency of the skin graft and of the adhesive rubber cement to contract but it should not be so thick as to fail to conform to depressions and elevations of the recipient defect. Further it should be unchanged by sterilizing or by contact with body fluids and it should be free of any tendency to cause dermatitis.

Any one of several transparent films now on the market might prove suitable for the purpose provided the requirements just mentioned were fulfilled. Oiled silk while translucent can be torn readily into strips of the desired dimensions and is used by Capt Darrel T Shaw who assisted us in the early work on this procedure while he was resident here. Although we are investigating various films phlofilm is the only one that was used in the cases herein reported and it was used because of a considerable supply that we had on hand. This was found to be satisfactory except for some loss of transparency after a few days of use. This is possibly due to the action of the rubber cement on the phlofilm.

PREPARING AND CUTTING THE FILM CEMENTED SKIN GRAFT

The curved surface of the dermatome drum is 10 by 20 cm. This may be divided into two equal squares by a scratch line across its surface for a guide to centering the film. A sheet of unwrinkled phlofilm is cut into an oblong strip 12 cm wide by 24 cm or more in length. A small notch may be cut at the center of one longitudinal edge also as a guide. The film is soaked in 70 per cent alcohol for twenty minutes

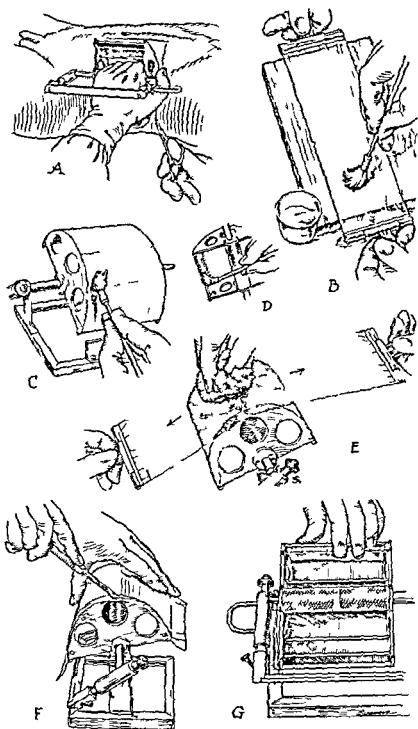


Fig 60—Covering the dermatome drum with transparent film A Outlining the donor site around the dermatome drum B Painting the film held at each end by broad paper clamps with rubber cement on a board A small notch may indicate the center of the film C Painting the dermatome drum with rubber cement A scratch mark indicates the middle of the drum. D Painting over the end and slightly inside the drum E Making the film held between clamps adherent to the drum F Trimming away the excess film from the edges with a scalpel G Tucking in the film over the drum ends

or it may be sterilized by soaking in 1:1000 merthiolate solution or other suitable disinfectant.

After the donor site has been outlined (Fig. 60 A) the film is gripped smoothly at each end with paper clamps approximately 12 cm wide

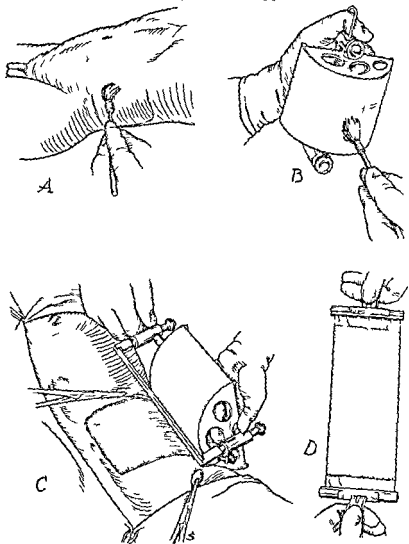


Fig. 61—Cutting the film-cemented graft. A: Painting the donor area. B: Painting the film over the drum. C: Cutting the graft which becomes adherent to the film with normal skin tension. D: The film-cemented graft removed from the drum being held by ten clamps for rubbing off cement retained on the film surface.

It is placed on a flat sterile surface such as a board painted with rubber cement and allowed to dry. The drum is likewise painted on its upturned outer surface and inside each end and is then allowed to dry. The strip of film held by the clamps is suspended over the drum

roughly centering it by the notch and scratch mark. It is then lowered until contact is made. Smooth adhesion everywhere is obtained by having the assistant rub the film with a dry sponge gradually progressing with a to and fro motion from the center toward each end. The clamps are removed from the film and triangles of film are cut away at each corner so as to permit the film to be folded over and tuckled inside the ends of the drum *without wrinkling* on the outer drum surface. It is important that the film lie smooth on the drum without folds or wrinkles especially at the entering edge of the drum; otherwise the film will be cut through by the blade and trouble may arise in cutting the graft.

The blade of the dermatome knife is adjusted by the micrometer screw to the desired calibration; the exposed surface of the film and the donor skin area from which the graft is to be removed are painted with rubber cement (Fig. 61) and the graft is cut in the usual manner.

The film with the adherent graft stretched out on it is pulled away from the drum and placed graft side down on a flat sterile surface, preferably a board moistened with normal saline solution. The clamps may be reapplied and any rubber cement retained on the film surface is wiped off with a dry sponge. The graft can now be handled, stored or applied to the recipient area without the slightest danger of becoming tangled or torn.

Additional grafts may be obtained and prepared in a similar manner, care being taken to wipe all rubber cement from the drum with a dry sponge after each use.

If more than one graft is to be taken, the employment of two drums will prove time saving, or if two are not available while the operator is occupied at the recipient area with applying or adjusting the film-cemented graft, the dermatome can be covered with a new sheet of film by an assistant or nurse.

APPLICATION OF THE GRAFT TO THE RECIPIENT AREA

The graft, seen through the transparent film, is adjusted into the most advantageous position in the recipient area. Care should be taken to plan that an amount of graft has been excised sufficient to cover the defect without undue waste. If the area of the defect is smaller than that of the graft, no piecing of grafts is required (Figs. 62, 63 and 64—upper arm); if not, the edges of adjacent grafts should be planned to correspond roughly to Langer's lines of skin tension on the part of the body involved so as to avoid subsequent bow-string contractures (Fig. 64—forearm and wrist; Fig. 65).

Several methods are available for immobilization of the graft in position. They may be divided into those of suturing and those of nonsuturing. Suturing is the more time-consuming but gives better chance of success.

Suturing Methods.—Of the suturing methods there are two types

One is the *overlap method* and the other is the *edge to edge method*. That with an overlap of the graft beyond the margin of the defect is the easiest and quickest but the resultant scars may be somewhat

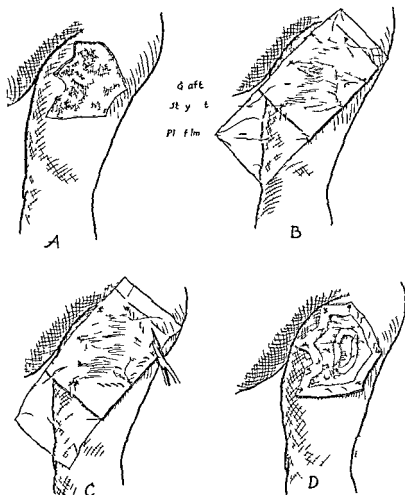


Fig 6 -Overlap method of suturing film cemented graft to deep defect. Removal of film beyond suture line

A Deep defect in arm

B Film cemented graft laid over defect and anchored to marginal skin by sutures. Note that not a full derm to me dr m of skin has been taken

C Film-graft margins sutured to edges of the defect and excess is being trimmed away

D Continuous basket stitch through the film and graft anchors the graft to the bottom of the defect. Drainage slit has been made and the film has been separated from the graft and trimmed away to all suture lines

wider. With this method (Fig 62) after tacking the film and graft about the defect with a few interrupted sutures continuous sutures are taken so as to approximate the graft and the margins of the defect

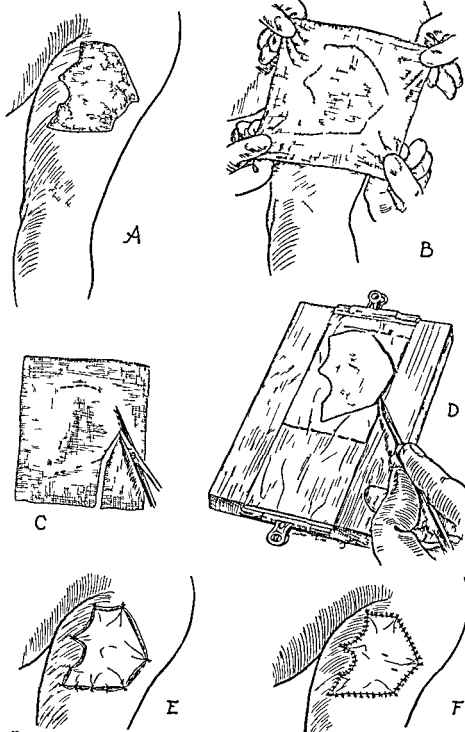


Fig 63 -Edge to edge method of suturing film cemented pattern graft to the margin of a flat defect

- A Flat defect on arm
- B Making blood stain pattern with an overlying fine meshed gauze A comparatively dry surface and a quick application prevents spreading
- C Cutting out the pattern along broken line to make it slightly smaller than the defect
- D Cutting the film cemented pattern graft
- E The edge of the defect is anchored to the film graft edge at several points Subsequent sutures approximate both edges closely everywhere
- F The film graft completely sutured in place with the film left on Small drainage slits are made through the film and skin in the direction of Langer's lines

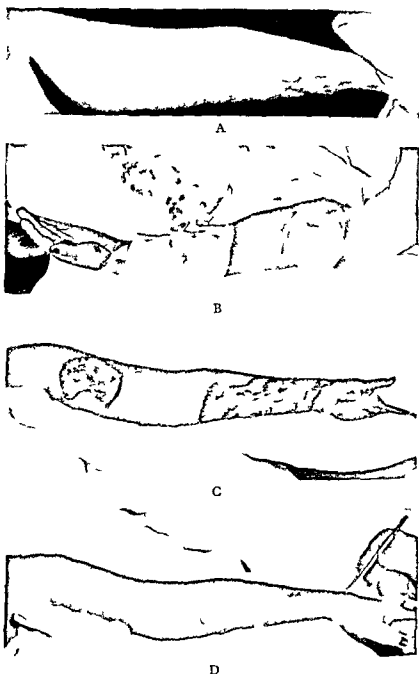


Fig 64—Scars from old burn on upper arm forearm and wrist with radio dermatitis threatening malignancy. Arm excised and covered with pattern film. Skin grafts using edge to edge method of suture. Film left intact (upper arm) and removed (lower arm and wrist).

A Condition before excision

The overlapping edge of graft and film is then trimmed away to the sutured portion

If it is desired to approximate the cut edge of the graft to the periphery of the defect with the edge to edge type of suturing (Fig 63), a pattern of the slightly moist defect is taken with transparent film fine mesh gauze or filter paper—the so called *pattern graft* of Kanthak.⁹ With the pattern on the film covered epithelial surface of the graft the outline is cut on a board with a scalpel or with scissors. Suturing of the film cemented graft to the edges of the defect is accomplished with unaccustomed ease. One can, of course lay the film cemented graft over the defect and trim it away to fit the defect without using a pattern.

With a lesion such as a *thick contracted scar*, it is inadvisable to cut a pattern according to an outline of blood made by incision about the lesion before it is excised for after excision the surrounding skin is drawn outward so much that a graft cut to this pattern will be too small. If the pattern is made after excision and retraction of the surrounding skin the graft from this pattern will be too large. With the ordinary split skin graft without the adherent film the graft is contracted and therefore, at the time of suturing an attempt is made to stretch the graft slightly outward and at the same time to bring the margins of the defect inward in order to approximate normal tension of both the graft and the surrounding skin. But the skin of the film cemented graft on which it is planned to leave the film after suturing (Fig 64 C—upper arm) is at normal tension and cannot be stretched or contracted because of the adherent film. Therefore the film cemented graft should be cut slightly smaller than the pattern taken from the abnormally relaxed defect and the margin of the defect must be brought in to meet the edge of the film cemented graft. In this way, normal tension of both will be obtained.

It is not so important to cut the graft smaller than the defect after excision of the lesion if it is planned to remove the film everywhere except along the suture lines because the contractility of the graft acts to draw the surrounding skin inward (Fig 64 C—forearm and wrist).

B Condition on eighth postoperative day with outer dressings removed leaving one layer of xeroform gauze over wounds. Note drainage slits along Langer's lines.

C Condition same day all dressings removed but with film and sutures still in place. Upper arm treated as in Fig 63. On forearm and wrist note edge of phofilm left about peripheral suture line and piecing at wrist as in Fig 65. The line of juncture of the two grafts corresponds with Langer's lines of skin tension.

D Condition on the fifteenth postoperative day one week after removal of sutures and phofilm. Note fine line of suture around pattern graft on upper arm which was cut smaller than the defect. Somewhat more superficial scaling may be seen on forearm and wrist where continuous sutures approximated skin edges. Note fine line of juncture between grafts (forceps) made possible by the film technique.

The edge to edge suture method of pattern grafting for a flat defect requiring two drums of skin is shown in Figure 65

While the film graft technique is satisfactory on flat defects it will

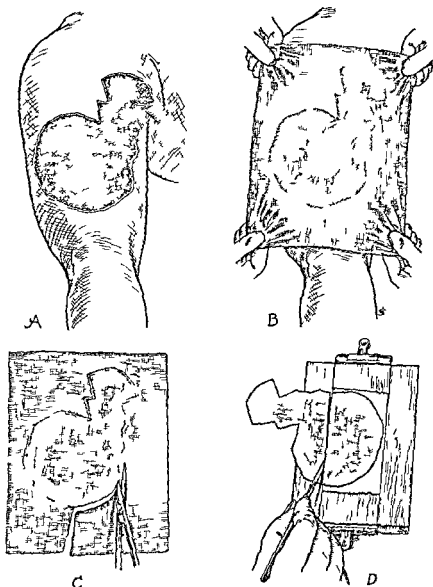


Fig 65 —The edge to edge suture method of pattern grafting for a flat defect requiring two drums of skin

A Large irregular defect of upper arm and axilla

B Obtaining the blood pattern on a sheet of fine mesh gauze

C Cutting the gauze pattern inside the blood stain margin as indicated by broken line

D Dividing the gauze pattern along the edge of the film graft with a scalpel. The graft raw surface down is then cut to the pattern

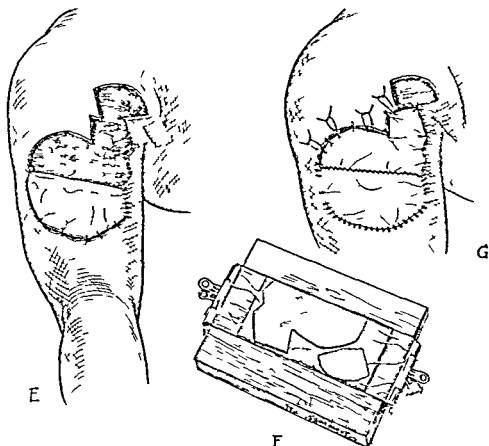


Figure 63 (Continued)

E Suturing the film-graft at several points with interrupted sutures. Subsequent sutures between these advance the retracted skin edge of the defect to approximate the edge of the inelastic film graft, thus re-establishing the normal tension of the surrounding skin. Broken line indicates where second and third pieces of graft are planned to join in the direction of Langer's line of skin tension.

F Remainder of pattern divided as planned and laid over film graft for cutting the second and third pieces.

G Second piece of film graft sutured at intervals to edges of the defect and to the first piece of graft.

be found on a *depressed* or *elevated* recipient area that because of the inelasticity of the film the graft does not closely conform to the contour of the defect and has a tendency to wrinkle. This is one of the major disadvantages of the film. Where the graft is not in contact with the tissues beneath it, serum, blood, or pus tends to accumulate and subsequent necrosis of the graft may occur. Over these depressed or elevated areas or when for other reasons there is wrinkling the film can be separated from the graft and trimmed away except along the lines where it is sutured (Fig. 62, Fig. 64 C—forearm and wrist). After the film has been thus removed the elasticity of the graft will permit contact with the surface of the defect with the application of pressure dressings. With no wrinkling of the graft and with proper dressing a high percentage of grafts should survive.

A film graft may be approximated to the margins of a defect by interrupted sutures with ends left long enough to be tied over a bolus of stuffed gauze so as to try to exert satisfactory pressure of the graft on the bed of the defect. This was done in one case (G B DaS) of total rhinoplasty in which the graft was intended to line the nasal cavity. There was a granulating area on the undersurface of a tubed pedicle flap which had been successfully brought up to the nasal region with satisfactory outer skin but with a portion of the inner lining lost. The granulations were excised leaving a sharply defined defect. The sutures were placed high in the nasal cavity with much more ease than if the graft had not been covered with film. They were then tied over a bolus and the film was left on the graft. A serous discharge observed on the second postoperative day became more and more purulent and on the fifth postoperative day when the bolus dressing was removed the graft was found to be necrotic having failed completely to take. This failure might have been considered due to infection but it was probably due to the fact that the desired pressure was exerted entirely upon the unyielding film rather than upon the bed thus causing poor contact between the graft and the recipient area. It would appear therefore that with the bolus type of dressing the film should be removed from all but the sutured portion of the graft.

With either the overlap or edge to edge suture method the suturing of the film cemented graft to the defect is much more readily done than without the film. The thinnest grafts which are usually torn during suturing and adjustment will remain intact when cemented to the transparent film.

Slits through the film and graft may be made with a No. 11 Bard Parker blade before removal of the film to allow drainage of fluids that as collections might separate the graft from its bed (Figs 62 D and 63 F). The slits should be small and should correspond with Langer's lines of skin tension on the body to minimize any resultant deformity. They are made much more readily through both the film and graft than through the graft alone.

Nonsuturing Method—If the nonsuture method of immobilization of the graft is desired for grafting over flat defects it is possible in selected instances to paint with rubber cement both the skin surface surrounding the defect and the undersurface of the film overlapping beyond the graft so that the two surfaces will adhere after drying. Extreme care should be exercised however that the traction on the skin by the film supplemented by that of the pressure dressing is not so great as to pull on the epithelium surrounding the defect enough to cause vesication, desquamation and subsequent pigmentation. It is usually better to cover the graft and surrounding skin with one layer of wide mesh gauze applying either rubber cement or collodion to the gauze and skin surrounding the graft and also if desired to the gauze and film over the graft.

Pieces cut from these large sheets of film cemented grafts of postage stamp or smaller size for transplantation on granulating surfaces have been used by Dr S Baron Hardy and Capt J Wallace McNichol as residents in this clinic. The film on the excised skin made application of these pieces simpler and easier than the usual method when the film is not employed.^{10 11} There are occasions when these small film cemented grafts laid on granulations may be preferable to the full sized grafts. The report of this method is printed in this volume.¹

Dressings—Before the dressing is applied at operation as suggested by Capt Darrel Shaw, dusting with sulfanilamide powder under any overlapping edges of graft may be done not with the idea of preventing infection but to reduce the moisture that may develop with the seepage of serum and the expected necrosis of the portions of the graft edge not in contact with the bed. The film cemented grafts are covered at operation with the same type of pressure dressings used on grafts without film, a single layer of fine mesh xeroform gauze usually being first applied in clean cases. Care should be taken that no wrinkling of the graft occurs. In two cases negacoll, an agar type of modeling compound, aided in maintaining smoothness of the grafts. Dressings are changed as is customarily done. It is observed that there is less adhesion of the dressings to the film-covered grafts than usual.

Removal of the Film—At the time of removal of the sutures—the fifth day or later with contaminated cases and about the tenth day in clean cases—it is found that the film has become slightly cloudy and translucent. The removal of sutures is markedly quicker and simpler than if no film had been used; the point of the scissors slides readily under the suture material without disturbing the graft. The film may be removed at any time desired after the fifth day when the adhesive properties of the rubber cement have decreased considerably and the graft has grown so strongly to its bed that it will not be disturbed.

REPORT OF CASES

The following representative cases are selected to show comparison between areas grafted by the film skin technic and those without the use of the film.

Case I—Three Contiguous Film Skin Grafts to Infected Flat Defect on Leg After Excision of Burn Tissue. Suture and Overlap Technic. Film Skin Graft Sutured to Bed and Film Left Intact. Simultaneous Skin Graft without Film to Similar Defect on Thigh.

E. O. a Mongolian idiot, aged twenty two years, was admitted January 28, 1943, following extensive third degree burns of both legs and thighs which occurred while she was tending an oil stove. The burned areas were dressed with sodium sulfadiazine ointment impregnated in a water soluble base on fine mesh gauze covered with zinc oxide and pressure dressings. At the first dressing on the twelfth day after admission, cultures of the left thigh showed hemolytic



A



B

Fig 66 (Cas 1) —Thrd degree burns of both thighs a d legs. Ne rot t sue of lo er leg and poster o reg on of thigh e c s d L er leg er d ith thr co t guous film skin grafts utu ed to edges th o e lap and thr gh graft to bed. Film left on. Gr ft to th gl ith ut us ng film.

A Cond t on of leg and thigh s th postoperat e day

B Closer vi of lo er leg sho ng sutures nd film remo ed from l west g aft but st ll n place on upper t v o grafts

coagulative negative microsc and d phth r id. At th s tm the thrd d gree burn areas looked htu h gray. Th same type of dr ssing a re ppld

At operation on February 11 1943 fourteen days after injury three dermatome drums of film cemented grafts were taken and temporarily stored. A fourth drum of skin was removed without the film. The third degree burn tissue on the posterior and medial aspects of the left calf was excised en masse by cutting down into the normal subcutaneous fat. The three sheets of film skin graft were then applied to the flat defect with the lines of the contiguous graft edges going around the leg circumferentially. The grafts were held in place about the periphery by a few interrupted sutures of dermal at several points. Continuous dermal sutures were taken around the periphery followed by continuous backstitch sutures across the face of each film skin graft immobilizing these grafts in situ. The overlap was trimmed away to the peripheral suture line and the film was left intact on the grafts.

The graft not covered with film was then used to cover an area on the posterior aspect of the left thigh after similar excision of tissue to subcutaneous fat. This graft was sutured as were the preceding grafts.

Drainage slits along Langer's lines were made through all the grafts which were dressed with xeroform gauze moist saline compresses and two 5 yard gauze rolls moistened with saline solution zinc oxide gauze and a firm pressure dressing. The wounds were dressed on the second postoperative day. Through the slightly cloudy film the grafts appeared to be in good condition and a few more drainage slits were made. Subsequent dressings were done on the fourth and fifth postoperative days. On the sixth postoperative day (Fig 66 A B) the grafts had taken well with only a few small areas of loss over slight collections of sanguinopurulent exudate. The sutures and film were very readily removed.

Both the film cemented grafts on the leg and that without the film on the thigh took equally well with little difference in the end result which was very satisfactory.

Case II—Single Film Skin Graft over Clean Superficial Unevenly Contoured Defect on Right Cheek Suture and Overlap Technic Film Intact Negacoll Dressing Subsequent Skin Graft to Left Cheek without Film

Major S. T. C., a Chinese aviator aged twenty eight years, was admitted July 29 1942 with old burn scars about the face received in 1939 during an air battle with Japanese planes (Fig 67 A B). Several reparative operations had been done by Mr. Kenelm Digby, Professor of Surgery at the University of Hongkong. At the Presbyterian Hospital in New York City several previous corrective operations were performed about the eyelids upper and lower lips and chin. On readmission on December 9 1942 the anterior portion of both cheeks still contained heavy pigmented scars.

At operation on the following day a film cemented skin graft 0.016 inch in thickness was taken with the dermatome from the right lateral



Fig 67 (Case II) - Scars of face of Ch. Lee, victim of bomb explosion, June 1939. Right cheek covered with film skin graft. Tridac. top. pharynx with or without help and below the eye with sutures between film graft and bed. Skin graft 1 ft. cheek without film technique.

A B Profile and frontal views July 22, 1941 before operation

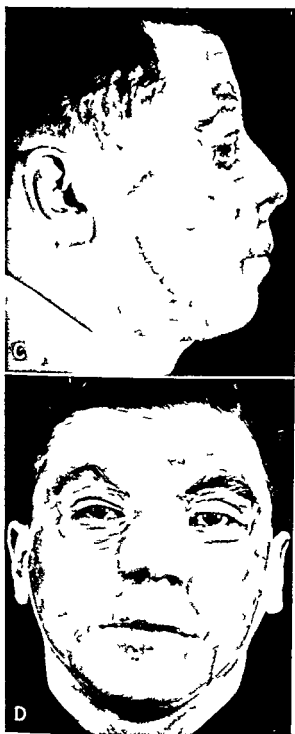


Fig 67 (Continued)

C Profile view one month after operation showing right cheek grafted with film technic. Other corrective operations have been performed.

D Condition December 1 1943. Right cheek one year after grafting with film technic and left cheek five and a half months after grafting without the use of film.

femoral region and was temporarily stored. The scar of the right cheek was excised with an incision line going laterally along the inferior orbital margin and down the posterolateral aspect of the cheek to the mental region. The line at the medial margin followed along the edge of previously placed grafts around the mouth and lip going up to the base of the right ala where it extended vertically alongside the nose reaching the starting point just below the inner canthus of the eye. The skin roller¹³ was used to remove the scar. Bleeding points were controlled by saline solution and adrenalin and by hemostats most of which were removed without being tied. A few ligatures of silk were placed.

The graft with the film attached was sutured with overlap to the margin of the defect by interrupted and continuous black B Deknatel silk sutures. A continuous suture on the superior portion approximated the graft and film to the bed. The overlapping edges of graft and film were trimmed away beyond the sutures and the film was left intact on the graft. Drainage slits were made in the direction of Langer's lines. Dressing consisted of a single layer of xeroform gauze and negacoll which was applied warm and allowed to solidify. On this was placed xeroform gauze and fluffed gauze. The dressing was held under firm pressure by elastoplast. The right upper and lower eye lids were sutured together by a single stitch and the eye was covered with fluffed gauze. An ace bandage completed the pressure dressing to the right side of the face.

The first dressing was done on the fifth postoperative day. The graft was found to have taken well. The wound was dry. All sutures and the film were very readily removed and a pressure dressing of xeroform gauze was applied.

Subsequent healing was satisfactory except that a small area pulled away slightly from the right upper lip. Figure 67 C shows the condition one month after operation. Other corrective procedures also having been carried out subsequently. Six months after the film skin graft to the right cheek a scar on the left cheek was excised approximately equal in size and similar in appearance, contour and location to that on the right cheek. The defect was covered by a split skin graft 0.012 inch thick cut by the dermatome from the right flank without using the film method. It was secured about the periphery by interrupted black B Deknatel sutures the ends of which were tied over a bolus of fluffed gauze covered by a single layer of xeroform gauze which also was used to protect the suture line. A pressure dressing with ace bandage was applied. The first dressing was made on the sixth postoperative day. All the graft was taking well but there was some pulling away of the margin near the mouth. Subsequent healing was satisfactory except for some wrinkling of the posterior portion of the graft.

At the end of a year the film skin graft on the right cheek proved

to be as satisfactory as the grafts on the lips and chin previously transplanted without using the film it looked slightly better than that on a corresponding area on the left cheek where likewise no film was used (Fig 67 D)

Case III—Film Skin Graft to Depressed and Elevated Denuded Area About Fingers and Part of Dorsum of Right Hand after Excision of Scar Due to Burn with Edge to Edge Suture Film Left Intact and Not Sutured to Bed also Contiguous Skin Graft without Film to Web and Dorsum of Thumb Two Months Previously Skin Graft without Film to Similar but Slightly Larger Area on Left Hand Wrist and Fingers

G W D a man aged forty two years was burned about the face neck and hands by the explosion of a gasoline tank on March 6 1943 The resultant scars on the dorsum of each hand became markedly thickened that on the right hand being worse than that on the left (Fig 68 A) Following irradiation the scars became softer more pliable and less elevated

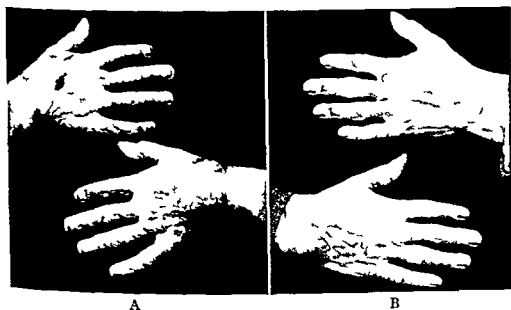


Fig 68 (Case III)—Burn scars of hand wrist and fingers Left hand grafted without film technic Right hand dorsum of thumb and web grafted without film technic remainder with film technic using edge to-edge suture method and without sutures to bed Film left intact on graft

A Condition of hands June 25 1944 three months after injury Note shortening of webs between thumbs and forefingers

B Condition January 17 1944 showing left hand four months after grafting The right hand is shown two months after operation without using film on dorsum and web of thumb but with film over dorsum of hand and fingers sutured edge to-edge about periphery and with film left intact on graft Note scarring of this area due to wrinkling Removal of the film is advisable with an uneven bed such as this especially when dressed with the fingers in flexion

The patient was admitted to the hospital September 20 1943 and at operation one day later the scar tissue was excised on the left hand

and wrist webs and dorsum of the fingers and web between the thumb and forefinger. A pneumatic tourniquet afforded a bloodless operative field. Darts were made at important points along the sides of the fingers to prevent subsequent bowstring scar contraction. The webs between the fingers and between the forefinger and thumb were deepened.

A single split skin graft 0.014 inch thick and without adherent film was cut with the dermatome from the right lower quadrant of the abdomen. This graft by itself was not large enough to cover the entire denuded surface without being stretched and tailored to fit. However by suturing one corner of the graft at the volar surface of the wrist and the opposite corner at the distal phalanx of the middle finger with cuts here and stretching there the single graft was made to fit the defect and was sutured edge to edge everywhere with interrupted silk sutures. Some difficulty was encountered in stitching at the webs between the fingers.

The hand was dressed with a single layer of xeroform gauze and pressure dressings with the fingers in flexion and the thumb in the position of apposition. On the eleventh postoperative day at the first dressing the graft had taken well with only a small moist area on the dorsum of the forefinger and also on the wrist. These areas healed satisfactorily and the graft subsequently became smooth and pliable.

Two months after the first admission and the day after the patient's second admission at operation the scar tissue over the dorsum of the right hand and fingers was dissected away in one piece using the same excision technic under tourniquet as was used on the left hand. The scar was thicker but of less extent than that previously removed from the left hand and wrist.

A film cemented skin graft 0.014 inch thick was excised with the dermatome from the left lower quadrant of the abdomen. Although a full drum of graft was taken and the defect was somewhat smaller than that previously made on the left hand the graft could not be made to cover the entire defect inasmuch as it could not be stretched. The film skin graft was trimmed slightly to fit the defect over the back of the hand and fingers leaving the web and dorsum of the thumb uncovered. Edge to edge approximation was obtained by suturing with some wrinkling of the film. No sutures were taken through the film skin graft to the bed because of the danger that puncture of the numerous large blood vessels there might produce hematomas. The film was *not* removed from the graft.

A small skin graft was removed by dermatome from the abdomen without the use of the film as there still remained a defect over the dorsum of the base of the thumb extending through the divided web to the palm. This was fitted over the remaining defect on the back of the thumb and into the web being sutured edge to edge to the periphery of the defect and to the edge of the contiguous film cemented graft. Drainage slits were made through both grafts and

the hand was dressed with the xeroform gauze and dry fluffed gauze and ace bandage under pressure with the fingers maintained in flexion and the thumb in the position of apposition

The first dressing was done on the tenth postoperative day. The graft without the film over the thumb was in excellent condition except for slight wrinkling. There was some moisture with considerable wrinkling on the film cemented graft over the fingers and the fourth metacarpal bone. A serosanguineous discharge was present beneath the wrinkled portions of the graft. The take here and at the commissures of the fingers was not as satisfactory as that on the left hand at a comparable postoperative time.

At the few points mentioned above the film covered graft subsequently became encrusted and healing was delayed in these areas with resultant scarring of the graft (Fig 68 B). The condition of the graft over the right thumb without the film was definitely better than that over the dorsum of the hand and fingers with the film. The graft without the film on the left hand was also better. At the time the photographs of these grafted hands were taken January 17, 1944, the graft without the film was four months old while that with the film was only two months.

Comparison of single factors such as the healing of skin grafts with and without the film in transplantation of skin may be conducive to misleading conclusions inasmuch as many other factors take part in producing the result. Differences in the application of dressings and the pressure exerted on the grafts may in themselves bring about varying results. The wrinkling of the graft on the right hand without the film indicated that on this hand the pressure dressing was not applied ideally. However, the graft on the left hand without the film was very considerably better than the grafts on the right hand both with and without the film while the one on the right hand without the film was definitely better than that with the film. Therefore in this location as well as in others where there are depressions and elevations of the bed it is important if the film is to be used to remove the film from the graft except at the suture line in order to permit the graft to come in contact with the bed by a satisfactory pressure dressing.

ANALYSIS AND SUMMARY OF CASES TO DATE

There has been in this clinic to date a series of sixteen cases in which the film technic of skin grafting has been tried. In one of these cases (OI) the plicofilm near the entering edge of the dermatome drum was wrinkled and was cut through whereupon the film and rubber cement were removed from the drum and the technic was abandoned. In another case (CM) in which the patient is still in the hospital the grafting has been done too recently for results to be reported. Therefore these patients are not included in the analysis of cases that follows. There were two cases (WB and WD) in which the film skin grafts

SUMMARY OF 14 CASES TREATED BY

Case	Age	Diagnosis	Instrument by Which Graft Removed	P t-term	Th. (mm)	Area Grafted	Same or Similar Area Grafted by Film, Same Operation	Similar Area Grafted without Film, Different Operation
J G 73 870	38	Burn scar upper arm radial derma	Dermatome	Yes	0.01	Left upper arm	N	N
		Burn scar left forearm radial derma	Dermatome	Yes	0.01	Left forearm and wrist	N	N
		Burn scar per arm, radial derma	Dermatome	Yes	0.01	Right upper arm	N	N
W D 0-331	41	Burn, 45" back, dorsal	Dermatome	N	0.010	Left grafts into small pieces	Yes	N
W B 05173	4	Burn, head and neck	Dermatome	†	0.008	On grafts to head and neck. Grafts cut into small pieces.	Yes	N

taken by the dermatome were cut into small pieces for application to granulations. One of these (W D) is being reported separately by Doctors Hardy and McNichol.¹²

Instruments—All of the film cemented skin grafts reported in this series with the exception of three cases were removed from the donor sites by the Padgett dermatome the film first having been cemented to the drum. In the three cases in which the dermatome was not used the grafts were removed by an adjustable skinning knife in December 1947. This knife was devised to cut grafts of predetermined thickness from strips of phiofilm cemented directly to the skin of the donor area without the necessity of first cementing the film to a drum. The skiver is still in process of being perfected. There is no reason why film can not be used also with the instruments devised by G V Webster and by J V Caltagirone.

Thickness—The majority of the grafts were 0.014 inch thick, two were 0.012 inch thick, and two were 0.008 inch thick. When, because of lack of available skin for grafting, it is expected that subsequent grafts will have to be taken from donor areas previously used, it is advisable to excise thin grafts at the first cutting.

Suturing—In only one case (P A) was suturing not done; the film skin graft in this case was definitely not as satisfactory as those that were sutured. Only 80 per cent of this graft lived, and the loss was probably due to poor immobilization on the abdomen.

FILM CEMENTED SKIN GRAFTS (Continued)

Method of suturing	Contour	Clean, Contaminated, Infected	Film Removed, Operated, Except, Intact	Dressing	Result	Comment
Edge-to-edge sutures, interrupted	Flat	Clean.	No	Cuz pressure	Excellent	Graft smaller than defect Film-graft deal procedure of this condition
Edge-to-edge sutures, central sutures, interrupted and continuous	Flat	Clean	Yes.	Cuz pressure	Excellent	Negative no good graft before cutting arm Fine scar where placed
Edge-to-edge sutures, central sutures, interrupted and continuous	Flat	Clean.	No	Cuz pressure	Fair	Intermittent numbness Cast should have been applied
Sutures, all small pieces.	Flat.	Infected.	No sutures required	Saline compound gauze pressure	Excellent	Graft were cut to small pieces 3 of the graft before cutting were reattached of 11 days 1 of 18 days Grafts with film as good as with film
Sutures, all small pieces.	Flat.	Infected	No sutures required	Saline compound gauze pressure	Excellent	Grafts were cut to small pieces those with film took as well as without

Of the eleven cases in which the grafts were sutured there was *overlapping* of the graft beyond the defect. All of these grafts had a few interrupted anchor sutures with continuous sutures between them. There was occasional necrosis of the periphery of the grafts under the continuous suture lines especially when the case was infected. There is always danger in grafting without film when continuous sutures are drawn so tightly as to cause necrosis. There is even more danger of necrosis with film cemented grafts as the skin is apt to be too tightly compressed by the sutures against the film. Therefore especial care must be taken to guard against drawing the sutures too tightly when suturing film cemented skin grafts.

The dusting of sulfanilamide powder under the overlapping edges of the film skin graft may reduce moisture quite appreciably.

There were three cases with the *edge to edge* method of suturing in one of which (JG) three pattern grafts were so sutured. The pattern graft on the left upper arm was smaller than the defect closure was made with interrupted sutures and the film was left intact on the graft. The scar about the graft was so fine as to be scarcely visible (Fig 64 d). The result was less satisfactory with the graft on the left forearm and wrist in the same case where the graft was cut to the exact size of the defect with closure by continuous sutures and removal of the film except at the suture line.

In one case of edge to edge suturing (GWD Case III) the graft

under the suture line was excellent despite some wrinkling and loss of the film graft over an uneven bed

The third case of edge to edge suturing was that of GBDaS described above (p 264)

It is believed that individual interrupted sutures give better results than continuous sutures although they take considerably longer to place Where interrupted sutures with the ends left long are placed in edge to edge suturing of film skin grafts for the purpose of tying the ends over a bolus to obtain pressure the film should definitely be removed everywhere except at the line of sutures Otherwise the un giving film will take up the pressure exerted by the sutures and not allow the graft to come closely in contact with the underlying bed

Suture Material—Sutures of smooth material such as of the dermal or nylon type are removed more easily from grafts without the film than are sutures of the silk or cotton type This is true also of the grafts in which film is used but there is less advantage in using smooth suture material with the film technic Sutures of either type are very readily removed from film skin grafts

Uneven Recipient Areas—In one case (GWD Case III) wrinkling occurred due partly to poorly applied pressure but probably largely due to the fact that the film was left intact on a graft that lay over a recipient area that was both elevated and depressed Unless on a perfectly flat surface it is better to remove the film except about the sutures This will allow the elasticity of the graft to be utilized so that the pressure dressings can force the graft everywhere to come into close contact with the underlying bed

Central continuous sutures may be laid previous to cutting away the film in depressed areas or where motion of the recipient area may be expected These sutures should not be placed too tightly

In one instance (HT) in which an abdominal flap was turned up and sutured to the palmar surface of the hand and fingers webs between the fingers were deepened with incision in one web passing between the metacarpophalangeal joints It was possible to tuck the film skin grafts into these depressed defects and hold them by a few anchor sutures at points where this was feasible The result was excellent because the film could be made to fold and come in close contact everywhere with the flat sides and bottom of the V shaped defects Such a result could hardly have been obtained without the use of the film

Drainage Slits—If the wound is not absolutely dry and a minimum of fluid collection is expected slits should be made in the film and graft in the direction of Langer's lines of skin tension In areas exposed to view where appearance is especially important satisfactory hemostasis should be obtained before applying the film graft so as to obviate unnecessary scarring from large slits

Pressure Dressings—Pressure dressings over single layers of verofom gauze were used in most of the clean cases in the series In two cases

negacoli was applied warm and allowed to harden to a rubbery consistency thus obtaining excellent contact everywhere of the graft to the bed. In all but one infected case (G B DaS) wet saline under pressure dressings were used which were changed at twenty four to forty eight hour intervals.

Comparison of Grafts with and without Film—In a number of cases grafts without film were taken and applied either to the same or a similar area at the same operation in which the film skin graft was applied or at a separate operation.

Of the four patients grafted without film at the *same* operation on the same or a comparable area three (E O W B and W D) showed results equally as good as those obtained with the film skin grafts and one (G W D) showed a result that was definitely better.

Of the seven cases grafted without film in the same or similar areas at *separate* operation the results in three (E P Major C and E O) were worse than those obtained with the film skin grafts in one case (I B) the result was equally good and in three cases (G W D P A and R K) the grafts without film were more satisfactory than those with film.

Limitations and Advantages of the Film Skin Graft Technic—With the film skin graft technic somewhat more time is consumed than without it, due to the necessity of applying an extra coat of rubber cement to the dermatome drum and to the film and waiting for the cement to dry. However inasmuch as only slight adhesion between the film and drum is necessary thinning of the rubber cement with ether will speed the drying process. Moreover the painting and application of the film to the drum can be so planned as not to delay the operation appreciably.

Another limiting feature of the film cemented graft and one which may trouble the operator using this technic for the first time is that the grafts cannot be readily stretched or tailored to fit defects of complicated outline. Also film covered grafts cannot be made to cover as large an area as can grafts without the film. If a defect is to be covered which is of an equal or smaller size than the film cemented graft but extends beyond its outline piecing is necessary. Grafts covered with film cannot be made to conform to or come in close contact with depressed or elevated beds because of the unyielding nature of the film. This causes wrinkling of the film and graft with subsequent loss a difficulty that can be overcome however by removing the film from the graft except at suture lines.

The use of film cemented skin grafts renders easier the handling of the graft between the time of its removal from the donor site and the time it is applied to the recipient area and prevents the graft from adhering to itself or being torn during manipulation. This is a decided advantage when working with thin grafts.

When the graft is adherent to film it can be applied at normal skin tension. Although this is theoretically desirable practically it seems to

make little difference in successful skin transplantation unless there are extremes of tension on the graft

Suturing of grafts to recipient areas with the film technic is greatly facilitated since needles pass more readily through firm film cemented grafts than through grafts alone which yield easily to pressure and may be penetrated with difficulty. The sutures are more easily and painlessly removed from film cemented grafts than from grafts without film.

CONCLUSIONS

1. A technic is described whereby split skin grafts may be cemented to transparent film under normal skin tension at the time of removal from donor areas by the Padgett dermatome or other skinning instrument.

2. A series of fourteen cases illustrating this technic is presented.

3. Film cemented skin grafts are more easily handled and sutured, and the sutures are more readily removed than from grafts without film.

4. Film skin grafts have certain limitations but methods for overcoming many of these are suggested. The technic is indicated in certain selected cases.

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THE USE OF SMALL PIECES OF FILM COVERED SKIN GRAFTS

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AND

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THIS is a method of applying split thickness skin grafts to granulation tissue which can be carried out with ease and simplicity. It includes the removal of the graft on phiofilm—a thin tough transparent membrane using the Padgett dermatome—the sectioning of the skin graft into pieces about postage stamp size or smaller—and the application of these pieces to the granulating surfaces approximately 1 cm apart. The membrane which covers the grafts facilitates their application by maintaining normal skin tension and by preventing the edges of the grafts from curling.

Approximately twice the granulating surface area may be covered by this method as would be covered if the graft were applied in the usual way—an important factor when the burned surface is extensive and the donor sites must be utilized to the maximum degree. Also by this method from the mechanical standpoint at least the percentage of take of the grafts is nearly 100 per cent since any oozing from the bed is allowed to escape about the periphery of the grafts and to be absorbed by the overlying gauze compresses. Thus the loss of graft due to separation from its surface by hematomas or serum is minimized. Pressure on these grafts seems to be a minor factor.

As will be brought out later the phiofilm does not in any way interfere with the take of the graft and its separation from the graft is practically spontaneous. Applying grafts in this way dispenses with time consuming suturing since all the grafts are fixed into position simultaneously with the mesh gauze. If the patient's condition is critical and it is wise to keep him under an anesthetic only long enough to remove the grafts they may be refrigerated in one piece and applied at some convenient later time at the patient's bedside without anesthesia and without any detrimental effect on the patient's condition.

This procedure incorporates into a single method a combination of ideas used by other surgeons. Not long ago Dr. J. P. Webster de

From the Division of Plastic Surgery Department of Surgery Presbyterian Hospital. The technic photographs were made at the Christie Street Hospital Toronto Canada with the permission and kind cooperation of the Department of Pensions and National Health.

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veloped the method of taking split thickness skin grafts with the Padgett dermatome on pliofilm and using the sheets of skin and pliofilm together not only to maintain normal skin tension but also to prevent tearing of the graft when suturing it in place. Some surgeons have applied various adherent materials to the split thickness skin graft after its removal from the donor site and before sectioning it into small pieces. Other surgeons have applied split thickness skin grafts cut in various sizes to granulating surfaces without the use of any material to prevent the grafts from curling.

We believe that the method set forth has a definite application in the treatment of extensive third degree burns where donor areas are at a premium. For cosmetic reasons it is recommended only in these extensive third degree burn cases as will be brought out later.

TECHNIC

The technic of cutting split thickness skin grafts on pliofilm as developed by Webster is being simultaneously described in this issue.

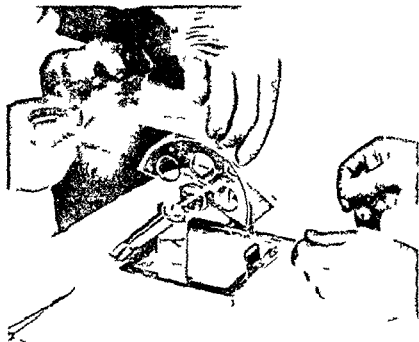


Fig. 69.—Application of pliofilm to drum of dermatome contacting surfaces having been coated previously with cement and allowed to dry. Carefully note technic of application of pliofilm to drum as it is of utmost importance that it be applied without any wrinkles.

in detail.¹ Briefly, a sterile sheet of pliofilm is previously prepared (either autoclaved or soaked in 70 per cent alcohol for twenty minutes and then dried thoroughly) of the exact width of the dermatome—4 inches and 12 inches long—that is about 4 inches longer than the cur-

cumference of the drum so that the ends may be freely grasped with the fingers. The drum is coated with rubber cement in the usual way one surface of the plio film is entirely coated with the exception of about 1 inch on each end and both the surfaces are allowed to dry. Care must be taken to keep the plio film on the stretch as it tends to curl about the edges after painting. The coated surface of the plio film is then applied to the dermatome drum.

Care must be taken to make the application of the plio film to the drum entirely smooth as any wrinkling produces an elevation in the plio film surface which interferes with the cutting of the graft. Indeed the knife may cut through the plio film at such points and the entire procedure will fail if the plio film is so cut. This is of greatest im-

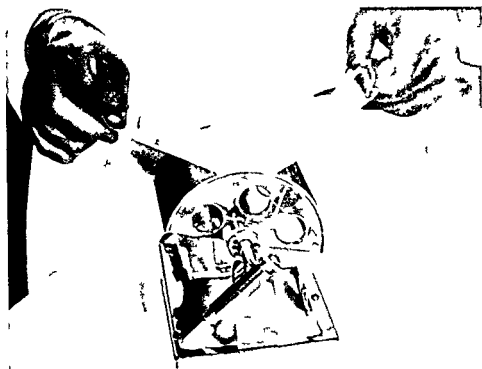


Fig 70—Removal of graft on plio film from dermatome drum

portance at the extremity of the drum where the cutting of the graft begins. It has been our experience that better application of the plio film is made when it is started at the center of the drum and continued toward either end (Fig 69). The ends of the plio film are then tucked inside the drum out of the way. The machine is set to the desired thickness which in this case we believe is best between 0.008 and 0.012 inch. The exposed surface of the plio film is then painted with rubber cement in the same manner in which the drum is painted. The donor surface is painted with rubber cement and after both surfaces have dried the graft is cut in the usual way according to the Padgett method. The graft is removed from the drum attached to the layer of plio film (Fig 70).

The pliofilm covered graft is now cut into small sections of about postage stamp size (Fig. 71). Plio film facilitates the application of the grafts since it prevents the skin from curling when it is cut into small pieces. Similar membranes may also be used for this purpose. It is common experience by all who have dealt with split thickness skin grafts that there is a tendency for the edges to curl on themselves particularly where the grafts are thin, whether or not their external surface is covered with rubber cement. This difficulty is multiplied many times when the sheet of skin is deliberately cut up into postage stamp sized pieces, as the edges of each individual piece must be rolled out in turn at the time they are applied to the recipient area.

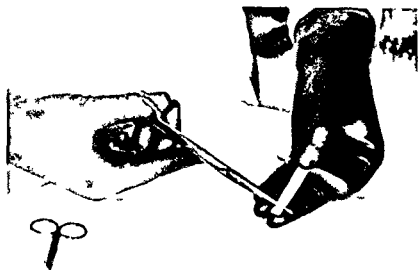


Fig. 71—Cutting grafts to size of about postage stamp

The grafts are then applied to the recipient area which should be as free of exudate as possible in distances up to 1 cm. apart. The granulating tissue should be firm, low and dark red in color. The grafts are held in position by a single layer of snugly fitting coarse mesh gauze placed over the entire grafted area and fixed about the periphery with collodion.

The dressings consist of a single layer of fine mesh gauze saturated with normal saline, over which are placed double layers of gauze compresses saturated in the same solution. Overlapping double sheets of zinc oxide gauze are placed over these layers of moist gauze in order to retain the moisture in the compresses. If an extremity is being grafted it should be supported by a gauze bandage. The dressings should be

changed daily down to the layer of coarse mesh gauze and it is recommended that these be undertaken by the operator if possible until after the fifth day when this type of dressing is changed to a dressing of fine mesh gauze impregnated with a bland ointment. Unusually gentle care must be exercised in the removal of the moist dressings so as not to dislodge the grafts from their beds. This is particularly important during the first few days. The coarse mesh gauze is removed on the fifth day after its application. If it is allowed to remain longer it will become imprisoned in the granulation tissue which tends to grow up through it and its removal will be difficult.

At this time the pieces of plicofilm which are on the surfaces of the grafts can be removed easily from the grafts with a pair of thumb forceps without injuring the grafts. In fact many of the pieces will come away with the coarse mesh gauze. On close observation it can be demonstrated that there has been between $\frac{1}{16}$ and $\frac{1}{2}$ inch growth of the grafts beyond the periphery of the pieces of plicofilm indicating that the plicofilm has offered no interference whatever with either the take or the growth of the grafts. The grafts are then dressed daily with xeroform gauze and compresses.

If the patient's general condition is poor and it is not advisable to prolong the operation in order to apply the grafts at the time they are cut they may be refrigerated and placed on the recipient area at some convenient later time at the patient's bedside in the same manner as described above. They should be refrigerated at about 4°C . Although grafts have been used with some success after they have been refrigerated more than twenty one days it is advisable that the refrigeration period be no longer than this period as the successful take of the grafts after this time is questionable.

CASE REPORT

W D a white man aged forty-one years was admitted with extensive second and third degree burns involving approximately 45 per cent of the body surface received when his clothing was ignited while he was in bed. The area burned (Fig 72) extended posteriorly from about the first thoracic vertebra to the heels and extended anteriorly on the chest and lumbar region to the midaxillary line. It extended around the right side on the abdomen to the anterior superior iliac spine around the thighs to about three fourths of their circumference and practically the entire surface of the legs and the dorsum of both feet. With the exception of the burns on the upper half of the back and a few other smaller areas practically all were third degree. The hematocrit on admittance showed hemolysis in plasma. At frequent intervals during his hospitalization period the patient was mentally confused occasionally to the extent of being completely out of touch with his environment.

Skin grafting procedures began on the twenty ninth day after admission. The granulating areas were treated with moist dressings using 1 per cent sodium sulfadiazine changed every three hours for twenty

four hours preoperatively. Approximately 2 1/2 drums of skin of 0.008 inch thickness were removed from the left arm but because of the patient's critical condition it was not advisable to continue the anesthetic and the grafts were refrigerated according to our usual technique.

On the eleventh day after the removal of the grafts some of the refrigerated grafts were applied to the back after being cut into postage stamp sized sections (Fig. 73). These grafts were not removed on

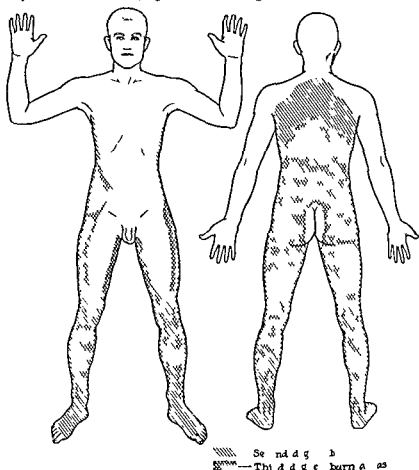


Fig. 72—Diagram showing surface areas involved in burn

pliofilm and because of this much time was consumed in their application due to the curling of the graft edges. The coarse mesh gauze was removed five days after the application of the grafts and two days later the remainder of the refrigerated grafts were applied. These had been refrigerated eighteen days. All grafts took very well.

On the forty ninth day six drums of skin were removed on pliofilm four of them from the right arm and forearm and two drums from the back which had been a second degree burn area but had now

healed These grafts were cut 0.010 inch thick and were likewise refrigerated Some of these were applied four days later to the right loin gluteal region right thigh the posterior aspect of the right and left legs according to the method already described (Fig 74) Five days later on the fifty eighth day the coarse mesh gauze was removed together with pieces of pliofilm which came away easily (Fig 75) All of these grafts took well with the exception of a few which were deliberately rubbed off by the patient



Fig 73—Thirty nine days after admission Grafts had been removed eleven days previously and refrigerated Note the coarse mesh gauze which has been painted with collodion about the periphery to maintain the position of the grafts No pliofilm was used on this set of grafts

On the sixty seventh day more of the refrigerated dermatome grafts were applied (refrigerated now eighteen days) using the postage stamp sized grafts on pliofilm with excellent results

On the 101st day after admission the remainder of the refrigerated grafts (fifty two days refrigerated) were placed on the anterior surface of both legs but the grafts failed to take It is evident here that the refrigeration period was much too long but nevertheless the trial attempt was made Eighteen days later on the 119th day subsequent grafting of these areas was carried out according to the usual technique of applying split thickness grafts in one piece and the grafting of the few remaining ungrafted granulating areas was completed as well as those over pressure points on both hips the lateral surface of the right thigh and the anterior surface of the right leg and right ankle The



Fig. 74—Fifty third day after admission. Lateral aspect of right thigh showing freshly placed postage stamp grafts in position. Majority of the phlofilm on them (white ones) have no pl. film and are used as controls. Grafts refrigerated four days and were 0.010 inch in thickness. Some of the squares of phlofilm were perforated but this proved to be of no advantage.

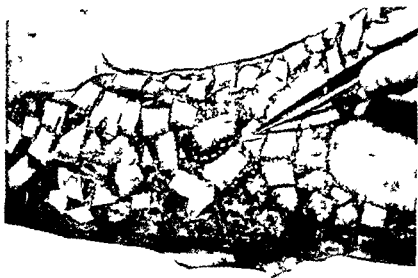


Fig. 75—Photograph of same area demonstrating the removal of pl. film after taking away the coarse mesh gauze.

grafts were cut 0.010 inch thick using a dermatome. The take of the grafts was very satisfactory.



Fig 76—Six months follow up photograph showing the lumbar region and the posterior thighs



Fig 77—Six months follow up photograph showing in detail grafts on the posterior and lateral surfaces of the thighs

Follow up photographs (Figs 76 and 77) show the results of this method of grafting approximately six months later

A summary of the case appears in the accompanying tabulation

COMMENT

As mentioned above the first set of grafts taken in this case were cut in the usual way using the Padgett dermatome and were applied to the granulating areas of the back after being sectioned into small pieces. So much time was consumed in applying the grafts due to the curling of the edges and the adhering of their surfaces that it prompted us

to try applying the grafts covered by a membrane to overcome this difficulty. In order to determine whether the plicofilm had any detrimental effects on the take of the grafts it was removed at the time of application from a few of the grafts chosen at random in the area grafted to act as controls. It was noted later that as far as could be determined the plicofilm in no way interfered with their take or their subsequent peripheral epithelization. The refrigeration of the grafts on plicofilm prior to their application likewise did not interfere with their take—at least certainly not those applied within three weeks. In the case reported we obtained practically 100 per cent takes of all the grafts applied.

SUMMARY OF THE CASE

No. of Days After Admission	Skinned L. Proximal Distal	With Plicofilm	Without Plicofilm	Thickness of Grafts	Graft Ref.	Days Refrigerated	Applied as Positioned Graft	Applied as Positioned	Areas Applied	Remarks
3	drums			005						Applied later
39				005		11			Back	Practically 100% takes
46				00		13			Back	Practically 100% takes
4	6 drums			010						Applied later
53				010		4			Right n. gluteal region, thigh and leg.	100% take except here debrided by patient.
67				010		13			Medial surface legs and thigh	Practically 100% takes
101				010		5			Anterior surface of both legs	All grafts fused
119	1 drum			010					Pressure point on hip, surface of thigh, surface of leg	Practically 100% take

We feel that the method of applying grafts according to the technique which we have described is the method of choice in extensive third degree burns where donor areas are at a premium and also in those cases of extensive third degree burns where multiple burned areas are involved and the patient's general condition does not permit prolonged grafting procedures where the granulation tissue is excised and the grafts are applied and sutured into position in the usual way. The application of grafts by the method described is relatively simple and rapid and we present it as a superior alternative to small deep grafts in the above situations. This method is not the usual method of

grafting the average burn case on the Plastic Surgery Service of The Presbyterian Hospital because the cosmetic results obtained are as a rule not as good as those obtained when dermatome grafts are applied in the usual way in a single sheet

Advantages—Postage stamp sized grafts removed on pliofilm may be applied to the recipient area with great rapidity because of the complete control of the edges of the individual graft so that there is no opportunity for curling since they are kept at normal skin tension on the pliofilm

There is a very high percentage of take in comparison with any form of large split thickness grafts in an infected field. There is an unusually good opportunity for free drainage about the periphery of the grafts which is a great advantage over any form of sheet graft as these wounds are at least bacteriologically dirty and demand adequate drainage

If the patient's condition permits general anesthesia of only sufficient duration to allow the graft to be taken the graft may be refrigerated and applied at a later date at the patient's bedside without any form of anesthetic since the grafts are placed directly on a good granulating bed

The donor areas are not destroyed and can be used again if circumstances demand in contradistinction to those areas from which small deep grafts have been taken. The cosmetic appearance of the donor areas from which the thin split thickness grafts cut by the Padgett dermatome have been taken is vastly superior to that of the areas from which small deep grafts have been removed. We have purposely stated thin dermatome grafts of a thickness of 0.008 inch to 0.012 inch in the event that it becomes necessary to use the donor sites again. This is not feasible in the donor sites of small deep grafts

The cosmetic appearance of the postage stamp graft although inferior to any form of sheet graft appears to be equal if not superior to that of small deep grafts

Disadvantages—A disadvantage of this method as compared with the usual application of dermatome grafts is as we see it in its cosmetic results. Also there is perhaps more scarring resulting from this form of graft

It is true that more time is consumed in the cutting of the graft through the process of applying the membrane to the dermatome and that this may be considered a disadvantage. However the ease and rapidity with which the grafts can be applied more than compensate for this time

CONCLUSIONS

A method is presented whereby split thickness skin grafts which have been cut by a Padgett dermatome on pliofilm and then sectioned into pieces of postage stamp size are applied to granulating surfaces in the treatment of severe burns

An illustrative case is included in which this method of skin grafting was employed with very satisfactory results.

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OPEN ABDOMINAL FLAPS FOR REPAIR OF SURFACE DEFECTS OF THE UPPER EXTREMITY

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THE repair of severe open wounds and healed scars of the upper extremity not infrequently taxes the judgment and technical ability of the plastic and reconstructive surgeon. Especially is this true of casualties of war and industry which may present extensive loss of skin and subcutaneous tissue as well as damaged underlying nerves, tendons and bones. Early well planned treatment considering the best possible end result and the several factors involved in obtaining it is to be desired. This is particularly true when the function of the hand is concerned.

Where skin is required to replace losses too great to be covered by satisfactory epithelization or by mobilization of skin from the surrounding area several methods are available. Superficial losses whether granulating or healed and contracted when there is present normal subcutaneous or areolar tissue may be covered by free skin grafts either thick split or full thickness as indicated. Defects which have exposed bones, tendons, joints or nerves which require subsequent operative intervention which need replacement of subcutaneous tissue for contour or padding or in which resistance to trauma is a problem are usually best covered by both skin and subcutaneous tissue. This requires the application of a flap consisting of both materials which is taken from another surface where it is not as useful and it is nourished while growing to its new position by an attachment or pedicle. The simple open flap is one of the oldest and best known procedures of plastic surgery. Its use is indicated less frequently than free grafts and in most instances it is not as desirable as a tubed pedicle.

Unlike larger areas of the body the hand, forearm, foot and leg do not have adjacent donor areas of sufficient size or nonfunctional importance to supply skin and subcutaneous tissue in quantity by rotated, advanced or sliding local flaps. However they do offer the advantage of being easily moved to the site chosen as the donor area. The time and technical difficulties involved in bringing tissue from a distance as represented by long tubed pedicle and jump flaps is thus alleviated. The hand and forearm are especially favored by being freely movable to the abdomen and lower anterior thoracic region where a large donor area is available. Besides being inconspicuously located the donor area is readily closed or grafted without subsequent disability. Open abdominal flaps are because of the anatomical location limited in use almost exclusively to the upper extremity.

ADVANTAGES

In spite of its limitations the open abdominal flap if used judiciously and with care is a definitely useful procedure with indications not enjoyed by other methods. The usefulness of the open flap has lost prominence because of the ability to do clean operations and the greater flexibility and length obtainable with tubed pedicle flaps which allow transfers to a distance.

An open flap permits early coverage of an open defect and may be successfully used as a method of wound closure as well as giving a satisfactory end result. Deep avulsed wounds may be covered immediately if it is thought advisable. When it is necessary to cover an open joint, bare bone, tendon, amputation stump and certain severe burns, it allows subsequent operative work on the underlying structures such as bone, tendon or nerve graft. Such procedures cannot usually be done beneath a free graft unless sufficient subcutaneous tissue is present or undermining is minimal. Early coverage of an open wound with tissue of sufficient pliability and blood supply has a very noticeable effect in allowing increased mobility of joints, diminished edema and freedom from pain and may greatly influence the end result obtained with the severely injured hand.

Where the wound or scar is extensive the application of the flap improves the circulation to the whole part involved. For instance it is possible to vascularize a cyanotic finger tip due to dense scar proximal to the involved area by replacement of the scar with a good flap graft.

The open flap on the abdomen requires one operation for application and one operation for division and revision although like all flaps the contour may be changed later by the removal of excess subcutaneous tissue. This is an advantage over the delayed flap or tubed pedicle flap which may require one or more preparatory operations before transfer thereby delaying the closure of open wounds and increasing the length of convalescence. When infected or contaminated wounds are covered by an open flap drainage is facilitated from the attached margin thereby lessening the chance of an infected pocket forming beneath the flap. On the other hand clean healed surfaces may be covered without excess scar in spite of an open wound at the base of the flap.

Old x-ray burns or avascular areas with involvement of bone, tendon or fascia may be grafted with an open flap after proper preparation and excision of the surrounding area of impaired vascularity. Free grafts which depends from the time of application on the blood supply of the base for growth cannot be used in these cases.

DISADVANTAGES

An open flap presents a certain amount of granulating wound on the under surface of the bridge between attached and applied portions which is contaminated and in which a varying degree of infection is

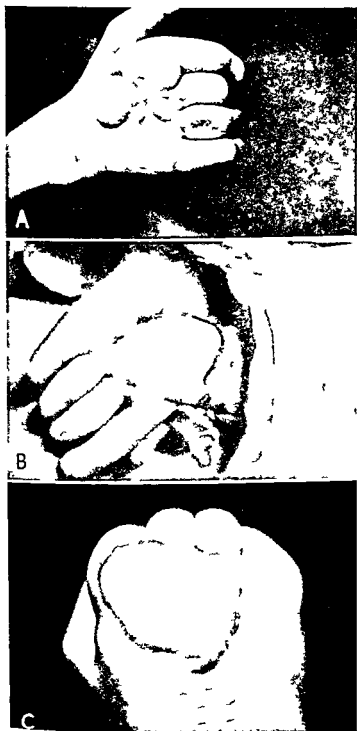


Fig 78 (Case I) — *A* Cicatrix on the dorsum of the right hand the result of a machine gun bullet wound adherent to fractured metacarpals with loss of extensor tendons to third and fourth fingers
B Two and one half weeks after excision of scar and application of abdominal flap showing flap applied
C After division of flap before tendon graft and removal of excess fat.



A



B



C

Fig 79 (Case II) —A Rifle bullet wound of left hand covered with small deep grafts which are adherent to bone joint capsule and extensor tendons
 B The condition of the left hand after excision of scar tissue of margin and freeing of extensor tendon
 C Applied flap with extensor tendon anastomosis. The second and fifth pedicle was shifted and folded into the palm

present Care is required in dressings and in the treatment of the wound In closing the wounds of the donor and recipient areas when the pedicle is divided the same careful technic should be used as in any secondary wound closure Healing should be primary if there is adequate hemostasis avoidance of trauma complete excision of granulation tissue and maintenance of adequate circulation provided the wound shows no virulent organisms with clinical evidence of cellulitis

It is stated that the granulating wound shrinks However when the open area is reduced to a minimum the shrinkage is negligible during the short period of application and has not proved a problem

With flaps whether open or closed by tubing or free grafting of the base there are the complications inherent in all tissue transplantation For instance those resulting from the surgeon's inability to judge the viability of tissue which has a diminished blood supply may be encountered

All flaps may be bulky or unsightly or may incompletely cover the defect if ineptly applied It is to be noted that the application of flaps is a method of necessity to be used when more simple and yet adequate procedures such as free grafting and mobilization of surrounding tissue will not give the desired functional or cosmetic result

TECHNICAL CONSIDERATIONS

Abdominal flaps can be made almost any required size or shape to cover the defect on the upper extremity The ability to rotate the hand and forearm and apply both to various locations on the abdomen allows freedom in the selection of the direction and the location of the flap Thinner skin may be obtained from the groin and lower abdomen while a thicker layer of derma is present in the upper abdomen and the lower thoracic region A minimal amount of hair is found laterally which is desirable in most instances Immobilization of the extremity for the desired time is easily accomplished by simple adhesive plaster dressings

A *single pedicle* flap is preferred to bridge or pocket flaps for several reasons A double pedicle is not required to give sufficient blood supply to the flap The donor area is not easily closed or grafted when the flap is raised This may leave a large granulating surface to be secondarily dealt with Even though a graft is applied beneath the pocket the chance of a complete take and a clean base is not as good as if it is laid on an exposed accessible wound The granulating area if not grafted at the time of application is not easily accessible for dressings As a result there is excess drainage and moisture which promotes infection and also maceration of the adjacent skin

It is important to have a small granulating area which can be closed without extensive undermining at the time of division of the pedicle Because of the excessively wide attachment of the bridge or pocket flap the pedicle may have to be divided in stages to assure that suffi

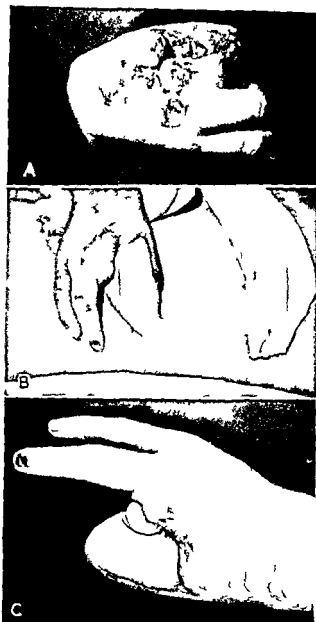


Fig 80 (Case III) — *A* Severe wound of right hand two and a half weeks after shell detonator exploded in the hand. The thumb is amputated just distal to the metacarpal phalangeal joint and bone is exposed. The first metacarpal is fractured.

B Two and one half weeks after excision and reconstruction of granulating wound and application of flap.

C Three weeks after reconstruction of flap and application to defects on palm and two-thirds of circumference of first metacarpal. Note distortion due to deep defect from loss of second and third metacarpals. Patient is able to write and use hand with normal first metacarpal movement, however the flap will be resected and excess fat removed.

ment blood supply has been established from the recipient area. Also two or more sides of the applied graft must be closed at the time of division, giving a more extensive wound for secondary closure. The simple pedicle allows more freedom of motion and position of the extremity for if it is carefully placed it may be turned back on itself or rotated without embarrassing the circulation.



FIG 81 (Case IV) —A Wound with amputation of the fourth and fifth fingers and metacarpals with exposed metacarpal bone and sloughing tendons two months after truck accident.

B Following excision of granulation and necrotic tissue and application of an abdominal flap

Almost any size of abdominal flap may be raised at the time of the application without the procedure of delaying it to increase the blood supply if a large enough attachment is maintained. This is practicable because of the several methods of application for any given defect. The base may be in one of several directions and may be made the length or breadth of the wound to be covered. Transverse excisions spread less upon healing because they follow the lines of normal skin tension as charted by Langer.¹ But if the vertical pattern of the blood vessels

supplying the skin and subcutaneous tissue of the abdomen is considered longer flaps with narrower bases can be used. Closure of the donor area will be easier without resorting to free grafts and closure of greater circumference of the applied flap is effected.

The rule that the length of the flap should be no greater than three times its width does not apply if the distribution of the anastomosing superficial epigastric and thoraco epigastric veins and their corresponding arteries which originate in the groin and axilla is utilized as advocated by Webster for the formation of long thoraco epigastric tubes. These vessels are found in the superficial fatty fascial layer of Camper which corresponds to the subcutaneous layer of the rest of the body. The veins can be seen through the skin of most individuals although the larger arteries are at a deeper level. Close to their origin in the axilla and groin or in the case of smaller branches the thoracic and abdominal wall the vessels penetrate the membranous fascial layer of Scarpa which is an important landmark in raising tubes or flaps from the abdomen.

OPERATIVE TECHNIC

At the time of operation the proposed incision on the abdomen is outlined with an aqueous solution of methylene blue after a pattern or careful estimation has been made considering the size, blood supply and method of application of the flap.

Preparation of Recipient Areas—The cicatrix or granulation tissue with marginal scar is completely excised before the flap is made thus a more accurate estimation of the defect is obtained. If the surgeon is in doubt about his ability to raise a viable flap to cover the wound the dissection of the cicatrix is done after the flap is raised and the blood supply ascertained. Whenever feasible a bloodless field is achieved by the use of a pneumatic tourniquet around the arm. This makes a cleaner and safer dissection possible.

Elevation of the Flap—The skin and subcutaneous tissue is incised to the thin fascial layer of Scarpa which is separated from the sheath of the underlying abdominal muscle by a layer of fatty areolar tissue. Elevation of the flap and extensive undermining of the margins for closure is easily accomplished in this plane. Only occasional perforating vessels are encountered. However undermining of the flap is done superficial to the fascia by the author. This layer of fascia is not desirable and the vessels may be seen beneath it and are avoided. In the lower part of the abdomen there is more fat beneath the fascia. It is not included since its presence increases the bulk of subcutaneous tissue.

Obese individuals may have more subcutaneous fat than is required. In this instance a certain amount of fat is carefully trimmed away without severing any large vessels. The edges of the flap are reduced in the same manner.

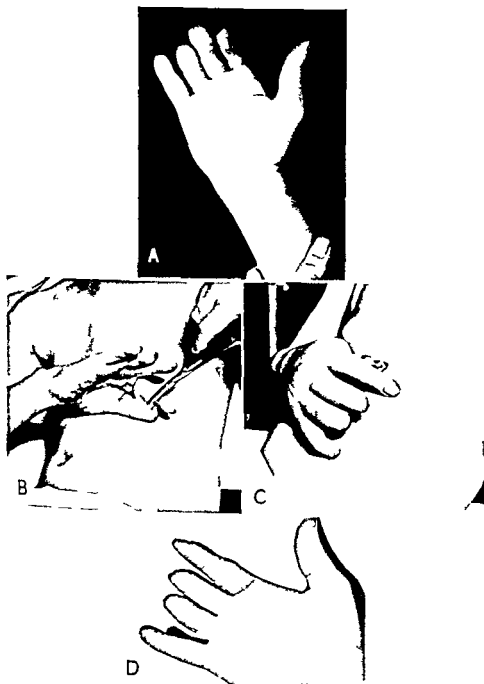


Fig 8 (Case V)—*A* Healed cicatrix of right index finger with flexor tendons adherent together and to the scar six months after a high explosive shell fragment injury. Both proper digital nerves are divided. Free grafts had been applied two times without success. The finger is fixed in the flexed position.
B Two and one half weeks after excision of scar, lysis of tendons, exploration of digital nerves and application of abdominal flap.
C Method of closure of this type donor area and granulating base of flap is shown. Note that the donor defect has been closed by undermining and excision of triangles laterally and medially leaving only the base of the flap open.
D Flap applied and after six weeks the patient has almost complete active flexion of the interphalangeal joints.



Fig 83 (Case VI) —A Wound of hand eighteen days following explosion of dynamite stick. Note the exposed tendons. There are multiple fractures of the metacarpals and phalanges and anesthesia in the distribution of six proper digital nerves.

B Abdominal flap applied after removal of thick split graft which was used for healing. The palmar fascia was also removed with scar tissue. The tendons and digital nerves were freed of adhesions. The abdominal flap could have been applied instead of the split graft.

C Shows the open base of the large flap and the donor incision which had been closed by undermining sixteen days after application.



Fig 83 (Continued)

D Healed donor area after removal of dressings showing typical closure of the base of the flaps. The favorable distribution of the thoraco-epigastric blood supply has been utilized.

E Applied flap before removal of excess fat from the distal margin and adjustment to the base of the index and middle fingers. The function of the hand is good. Lysis of tendon adhesions of the flexors of the fourth and fifth fingers to give more flexion and nerve graft to the index finger will be done when excess fat is removed.

For closure the base of the flap is extensively undermined to permit approximation of the skin edges as close to the pedicle as possible without constricting it. Rarely the pedicle can be tubed at this time in thin individuals who have small recipient areas.

If a free split or three quarters thickness graft is used to cover the donor site it is also sutured onto the open base of the flap close to its attachment to the extremity.

Size of the Flap—The flap is made larger than the defect and long enough to allow a pedicle which will give some freedom of movement. Sufficient length is important to prevent pull upon the suture line permit

inspection and easy dressing of the base and prevent pressure or tension. In addition it allows sufficient material for closing the margins of



Fig 84 (Case VII) — *A* High wound with loss of the middle two-thirds of the ulna the result of a high explosive shell fragment.

B Applied flap three weeks after division of the pedicle.

C Healed donor area on the right side of the abdomen which was covered with a dermatome graft from the left abdomen when the flap was raised. A bone graft has been inserted beneath the flap.

attachment of both the donor and recipient wounds at the time of division.

Raising an excess of as much as one third the size of the defect to be covered has been advocated. Sufficient graft should be used to give normal skin tension when sutured and should cover the defect with ease. Flaps with a questionable blood supply sometimes develop venous congestion due to collapse of the walls incident to primary shrinkage of the flap when it is first elevated. This is corrected when it is sutured to the recipient site under normal tension.

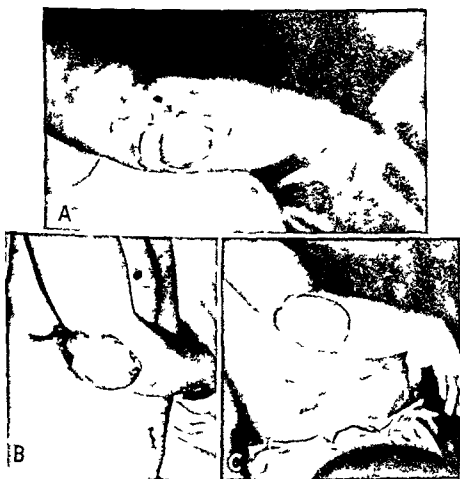


FIG. 8. (Case VIII) —A Scar adherent to fractured and ankylosed elbow the result of a gunshot wound.

B Flap on defect after three weeks. Note the superficial dry necrosis of the skin on the tip which has not been disturbed.

C Applied flap two weeks after division. The superficial necrosis of the tip is healing with little scar. A longer flap with better blood supply could have been taken in an oblique direction with the tip pointing to the groin.

Insuring an Adequate Blood Supply—Venous congestion evidenced by a livid color is a hazard not infrequently encountered. It may be due to pressure on the pedicle or inherent in the blood supply and is caused by a disproportion of arterial supply and venous return. Venous thrombosis will occur and result in necrosis of part of the flap if it is not corrected. A moderately firm dressing exerting the correct amount of

pressure may prevent this complication. On the other hand when the arterial supply is deficient the flap becomes pallid and the same end result can be expected with less chance of rectification. If the cause is

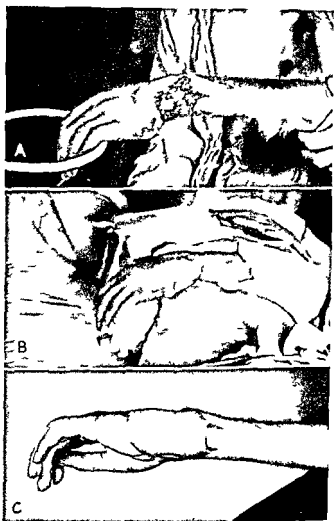


Fig. 86 (Case IV) —A Wound of wrist with an ulnar nerve defect, exposed carpal bones and sloughing tendons three months after injury by high explosive shell fragment.

B Applied flap two weeks after reconstruction of granulation and necrotic tissue.

C Flap divided two weeks after application but resloughed one week later because of cellulitis of the base. Some motion is returning to the wrist.

too much tension or constriction of the pedicle the circulation can be improved by appropriate alterations.

At the operating table circulation is estimated by gentle pressure with a finger. The point of pressure blanches and upon removal of the finger

blood flows into the flap. The time taken for the blanched area to regain the original color is a valuable roughly quantitative measure of the blood supply. The test is equally useful with livid or pallid flaps. The completely pallid flap of course does not blanch. Trauma associated with the incision can cause the circulation to be temporarily embarrassed.

To avoid trauma which may mean the loss of some of the graft the flap if handled by instruments is manipulated by skin hooks or fine thumb forceps applied to the derma.

Suturing—A few subcuticular sutures are used to apply the flap. They aid in the accurate approximation of dissimilar skin margins and



Fig 8 —Typical adhesive plaster pressure dressing as used to immobilize the flap to the abdomen after application of a flap.

relieve the tension on the skin sutures. If the circulation is borderline taut skin sutures cause necrosis of the skin margin.

The author uses fine white twisted nylon sewing thread for ligatures and buried sutures. Slightly heavier buried suture material is sometimes required to close donor areas. Fine black braided interrupted silk or nylon sutures are used for skin approximation.

Dressings—A single layer of ointment gauze dressing is applied to the open wound. It is not removed when the dressing is changed but remains in place until the pedicle is divided unless there is an accumulation of material beneath it.

A pressure dressing is considered important not only to prevent any accumulation of serum beneath the incision or flap but to promote better healing. The dressing is massive to distribute pressure evenly and to absorb moisture. Skin surfaces are separated from each other by pads and the extremity is immobilized by adhesive plaster (Fig. 87). Painting the skin with some form of skin varnish or compound tincture of benzoin protects it to a certain extent and also allows a firmer attachment of the adhesive plaster.

After care — The tip of the flap is inspected after twenty-four hours to check the circulation by removal of a small window in the dressing. The primary dressing and removal of most of the sutures is done after five or six days. Dressings are changed every two to four days so that they do not get moist. If the drainage is excessive, sulfanilamide crystals or powder is dusted on the granulating surface.

When slight superficial necrosis occurs as evidenced by the formation of blebs or crusts, they are not disturbed but are permitted to separate of their own accord. If the necrosis is deep or infected, allowance is made for drainage by removal of sutures or opening of blisters. The dead tissue is not cut away before a definite line of demarcation is present and separation is beginning to occur.

At the end of two to two and one-half weeks the pedicle is divided, the granulating portion is completely excised, and the edges are adjusted and closed without drainage. Occasionally it is thought safer to leave the flap attached for a slightly longer period. Though the attached portion may be vascularized as early as eight to ten days, the additional time gives a margin of safety in handling and adjusting the edges.

If operative work is to be done under the flap subsequent to application, the scar of one margin is excised and the flap is elevated as required. The extent of elevation is determined by estimation of the circulation at the operation. The time interval after application is determined by factors related to the underlying and associated pathological processes. The minimum time of two or three weeks is often exceeded.

SUMMARY

The advantages, disadvantages, and indications for using the open abdominal flap for repair of certain types of surface defects of the upper extremity have been discussed. A few of the technical details considered important by the author have been emphasized. The illustrations presented indicate problems encountered and methods used in application of this type of repair.

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THE ROLE OF FREE SKIN GRAFTS IN SURFACE DEFECTS

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FREE skin grafts are divided into three main groups the full thickness skin graft the split skin graft and the epithelial graft The *full thickness skin graft* is one in which the entire thickness of the skin is removed from one portion of the body and placed upon another area A *split skin graft* is one in which the dermis as the name implies is split in various thicknesses always leaving enough of the dermis upon the donor site to grow new skin The *epithelial graft* is one in which the epithelium only is removed and used as a graft

Since skin losses are the result of various types of trauma ranging from excessive heat—such as flame chemical or friction burn—or extreme cold—such as severe frost bite—to injury from missiles it is essential that this defect be repaired as soon as the recipient site will accept a graft If the skin loss is due to mechanical injury i.e. by knife or flying missile the denuded area can often be grafted immediately thus saving much discomfort time and in many instances deformity Loss due to freezing is more difficult to handle because of the poor blood supply of the surrounding and affected area while loss due to burns whether of flame or chemical origin causes considerable destruction of the underlying tissues and the surgeon must wait for the slough to separate in order to acquire a healthy granulation surface upon which to graft

SPLIT SKIN GRAFT

The split skin graft (see Figs 88 to 94) is the most practical type not only because of its ease of procurement but also because of the lack of permanent damage to the donor site This type of graft may be removed by a knife Padgett's dermatome or the Caltagirone apparatus The method of acquiring a split graft will vary with the individual surgeon and the availability of proper equipment and facilities

Preparation of Recipient Area—In cases of recent injury without destruction of the underlying tissues grafting may be performed immediately In such cases thorough cleansing of the denuded area with soap and water plus hemostasis is all that is necessary to produce a proper field for graft application A layer of fatty tissue is not conducive to a successful result, hence it is advisable to remove excessive fat before placing a graft In cases of tissue destruction all slough must

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The opinions or assertions contained herein are the private ones of the writer and are not to be construed as official or reflecting the views of the Navy Department or the naval service at large

be removed before transplantation. The majority of cases present a granulating surface and this tissue must be firm, red in color and not

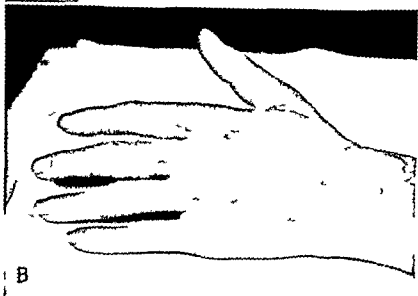


Fig. 88—A. Flap turn of dorsum of hand. Healed with considerable scar tissue, preventing complete function of fingers. B. Result. Ectension of impeding scar tissue and immediate repair of the defect. The plastic graft completely healed in ten weeks. Patient returned to duty.

edematous for successful application. All redundant granulation tissue must be either cut off or reduced with the iodine and glycerine method as advocated by Curler.¹ A 4 per cent boric solution as a con-

stant wet dressing is very efficacious in the treatment of redundant and infected granulations

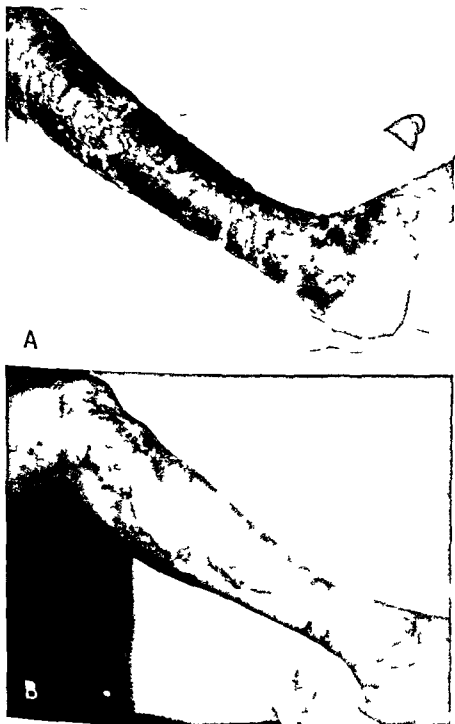


Fig 89—*A* Flame burn third degree of lower leg and foot. Repaired with split skin grafts. *B* Completely healed in nine weeks. Patient returned to duty.

The *cold quartz grid* is also very useful in cleaning up badly infected and edematous granulations and the method as advocated by Com

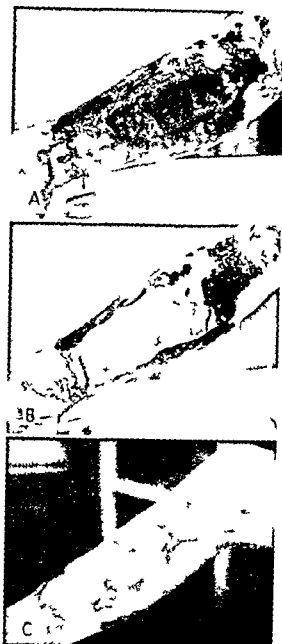


Fig 90—A Gasoline flame burn third degree of lower leg B A complete take of one single split skin graft's appearance C Leg healed in ten weeks Patient returned to duty

mander H B Arnold is as follows Main emission (95 per cent) at 2537A Distance 30 inches from grid to area Time First exposure 30 seconds Sixty seconds exposure may be used in some instances

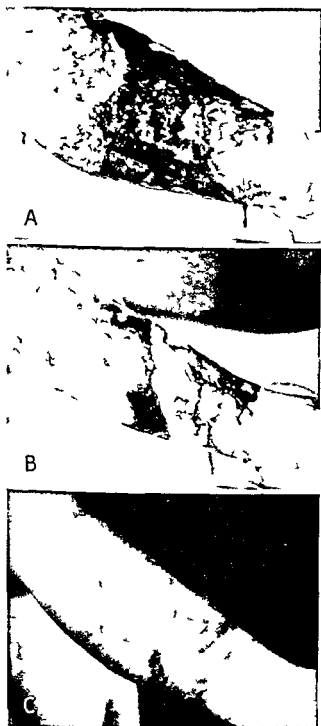


Fig 91—*A* Acid burn of lower leg. Four per cent boric solution plus cold quartz lamp irradiation preliminary to grafting. *B* The split skin grafts ten days postoperative. *C* Leg healed in twelve weeks. Patient returned to duty.

Smaller areas may be treated from a distance of 20 inches for 30 seconds. All areas should receive vertical rays as much as possible. Normal skin and eyes should be protected. It is routine in our institu

tion so to treat all granulations forty eight and twenty four hours preoperative. With this method it has been possible to clean up purulent and edematous granulations in as short a period as forty eight hours.

Should there be any question of blood supply of the recipient area vascularity is measured by the intravenous injection of 10 cc of 5



Fig 9 —A Flame burn of neck and anterior chest third degree. Four per cent boracic ointment plus cold quartz lamp irradiation preliminary to grafting. B Split skin grafts in place demonstrating suture pressure method of holding gauze in place. C Neck and chest healed in eight weeks. Patient returned to duty.

per cent fluorescein made soluble with sodium bicarbonate. Examination should take place in a partly darkened room using a mercury vapor lamp with adequate filter. Healthy granulations acquire a greenish yellow appearance. This is a modification of the method for ascertaining the circulation time as described by Drs. Kurt Lange and

Linn J. Boyd This injection method is also used in determining the blood supply of flaps whether tubed or open.

Postoperative Care of Grafts—After the graft has been applied *firm fixed pressure* is essential and the method of obtaining this is somewhat individual with each operator. It is our custom to suture a graft in place leaving the sutures long enough to be tied over gauze thus obtaining firm fixed pressure (Fig 92 B). Rubber T tubes are interspaced throughout the pressure dressings so that they can be kept moist with 4 per cent boric solution. With the suture pressure method we have been able to free graft areas which heretofore have been extremely difficult or impossible to repair without the use of attached grafts. Unless suppuration or other conditions prohibit the dressings are left in place for from seven to ten days. After the initial dressing is removed a lighter covering is applied utilizing either wet dressings of 4 per cent boric solution or an ointment gauze consisting of boracic acid and lanolin or scarlet red.

The boracic ointment gauze is made by impregnating gauze with equal parts of boracic ointment and lanolin which is sterilized by the autoclave. The *scarlet red ointment gauze*, as advocated by Bettman is prepared as follows:

Oxyquinoline sulfate	0.6 gm	gr x
Chlorbutanol (chlorotone)	7.4 gm	gr xxxvi
Liquid petrolatum	40 cc	dram i
Scarlet red ointment 5 per cent	170 gm	oz iv
(When 10 per cent scarlet red ointment is used take 2 ounces and petrolatum 2 ounces)		

The oxyquinoline sulfate and the chlorbutanol are ground separately into fine powders and then mixed separately with portions of the liquid petrolatum. All the ingredients are then made into a red ointment. The finished ointment is heated until fluid and rolled gauze bandages 32 by 44 mesh or coarser are immersed in the hot ointment until the entire bandage is thoroughly impregnated and until all bubbling has ceased. When cool it is ready for use. The finished product has been called *oxyquinoline sulfate scarlet red gauze*.

The formula herein presented will impregnate completely three 10 yard gauze bandages 2 inches wide or six 1 inch wide provided it is heated in a small container for example an aluminum measuring cup such as is ordinarily used in the kitchen.

When a bandage has been immersed in the ointment as described the mesh of the outer layer or two is covered completely and those layers are discarded. The warp and woof of the rolled gauze are completely impregnated with the red ointment but the interstices are open. A bandage so prepared will keep indefinitely if contamination is avoided.

Care of the Donor Site—In cases of split skin removal the donor

site is dressed either with three layers of boracic acid and lanolin gauze or the scarlet red ointment over which a firm dressing is applied. After a period of from twelve to sixteen days the dressing is

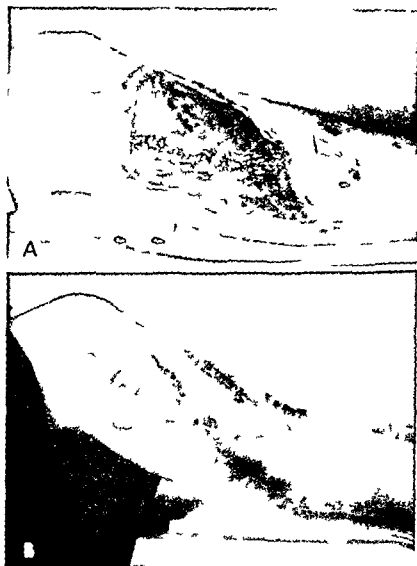


Fig 91—A Mole wound of lower leg first seen fourteen days following injury. Granulations treated with four per cent boric solution and cold quartz lamp irradiation preliminary to grafting. B Split skin graft applied. Completely healed in eight weeks. Patient returned to duty.

removed and the donor site is usually completely healed. In some instances we have used the same donor site for more than one crop of skin.



Fig 94—*A* Knife wound of upper arm *B* Defect grafted with split skin graft
Completely healed in four weeks Patient returned to duty

FULL THICKNESS SKIN GRAFT

The full thickness skin graft is most applicable for small defects of the face where color match is essential. It is obtained by dissecting the entire thickness of the skin free of fat from the donor site. The

donor site is then repaired by suturing the defect and undermining the surrounding skin if necessary. The posterior surface of the ear and the upper eyelid are common sources for small grafts. Full thickness skin grafts from the body to the face may take successfully but there is usually a difference of color and no amount of exposure will change the color of a transplant sufficiently to make it match the surrounding skin hence the reluctance of many surgeons to place body full thickness skin grafts on the face except in extremely urgent cases. Moreover if the graft is large the defect caused by the removal may in turn have to be grafted by a split skin graft and in reconstructive surgery it would seem unwise to mutilate unnecessarily one portion of the body to repair another.

EPITHELIAL GRAFT

The epithelial graft is somewhat limited in its use because of its thinness. It is an ideal type of graft for mobile surfaces such as the eyelid the lining of the orbital or similar cavities or in the formation of a buccal sulcus.

CONCLUSIONS

In the treatment of a large number of surface defects resulting from war injuries the split skin graft is the most practical because of its availability its surety of take and its lack of disfigurement of the donor site. The full thickness graft except when small and taken from similarly exposed areas is impractical not only because of the color differentiation but also because of the destruction of the donor site. The epithelial graft is good for the repair of mobile surfaces and the lining of cavities but because of its thinness it does not prevent scar contracture when applied over large areas.

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THE SURGICAL TREATMENT OF MALIGNANT MELANOMAS OF THE SKIN

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AND

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INCIDENCE AND DISTRIBUTION

A MALIGNANT melanoma of the skin may appear in any part of the body surface. Of the 162 cases of malignant melanoma of the skin recorded in the Laboratory of Surgical Pathology of the College of Physicians and Surgeons of Columbia University 1905-1940 the distribution was as follows:

Head and Neck		47
Scalp	1	
Auricle	5	
Forehead	4	
Face	20	
Mastoid	3	
Neck	9	
Trunk		78
Back	7	
Chest	8	
Abdomen	10	
Pudendal	3	
Upper Extremity		24
Arm	13	
Forearm	7	
Hand	{ Hand 1	
	{ Finger 1	
	{ Subungual 2	
Lower Extremity		51
Gluteal	4	
Thigh	5	
Leg	5	
Foot	{ Foot 31	
	{ Toe 3	
	{ Subungual 3	
Unknown Origin		17
Total		16

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An examination of the distribution on the body surface shows that *no region is exempt* (Fig 95). In this series there were two comparatively small areas where malignant melanomas occurred most commonly—the head and neck with forty two cases and the feet with thirty seven cases. The difference between this last figure and the four cases found in the hand is remarkable.

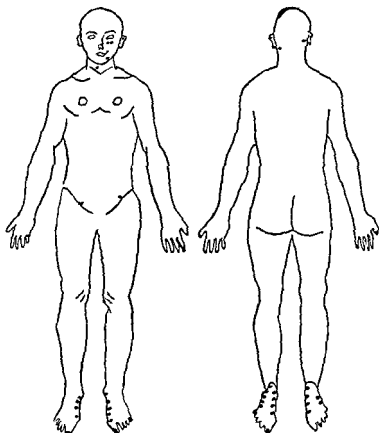
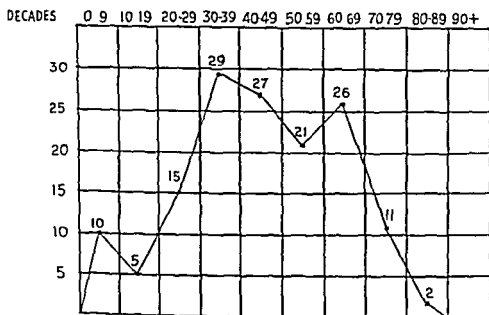


Fig 95—Distribution of 16 cases of malignant melanoma of the skin recorded in the Laboratory of Surgical Pathology, Columbia University (see text)

Malignant melanoma can occur at any age (our youngest patient was three and our oldest eighty two years old) but the greatest number of our cases were found in the four decades from thirty to sixty nine inclusive (Fig 96). There was a somewhat higher percentage of incidence in the female (56.8 per cent) than in the male (43.2 per cent) in a series of 155.

Since it has been said that these lesions rarely occur in Negroes it is of some interest that six of the patients in this series were Negroes.



SEX OF 155 MALIGNANT MELANOMAS OF THE SKIN
 FEMALE 88 [56 8/] MALE 67 [43 2/]

Fig 96—Age at diagnosis in 146 malignant melanomas of the skin. This indicates that the greatest number of lesions is found in the four decades from 30 to 69 inclusive.

RESULTS OF STIMULATION AND INADEQUATE TREATMENT

There was considerable evidence that a majority of the malignant melanomas started from pre existing moles. In this series information exists as to whether or not a mole preceded the development of the melanoma in 104 of the 162 cases. In sixty eight (65.4 per cent) there is evidence that a mole preceded the development of the malignant melanoma while in the remaining thirty six (34.6 per cent) the malignant growth seemingly arose without evidence of a preceding mole. In the other fifty eight cases definite information is lacking as to whether or not a mole preceded the malignant tumor. The evidence accepted as valid is either the statement that a mole had been present for many years or for life or the discovery of characteristic mole cells associated with the malignant tumor cells in the microscopic preparation.

Of these sixty eight cases of malignant melanoma preceded by a mole it was reported that the mole was traumatized in thirty six patients. The trauma was caused by a physician in nineteen and by the patient in twenty one (in four the trauma came from both sources). In the remaining thirty two either no trauma was reported or information on this point is lacking. Trauma caused by the physician came from attempts to remove the mole by physical or chemical methods which did not succeed.

If all 162 cases of malignant melanoma are considered it is found

that trauma was done to the lesion or its antecedent mole or that the growth first appeared after the receipt of trauma in seventy-one cases. In thirty-nine the physician caused the trauma by ineffectual attempts to remove a local pigmented lesion. In forty-two the patient reported the trauma (10 cases were traumatized by both). Of the remaining ninety-one cases no trauma was reported in fifty-one and information was lacking in forty.

This means that one fourth (24 per cent) of all these malignant melanomas or the moles which preceded them were known to have received improper inadequate treatment by a physician.

CASE I—V G, admitted January 1, 1938, was a thirty-two-year-old single white traffic officer who had been disabled for five months because of a backache thought to be traumatic. He had a chronic cough with pleuritic pain and had lost 45 pounds in weight.

He had always had a brown mole on the left cheek and this had slowly enlarged during his life. Three years before admission the mole had been described as being on a brown blotchy scar which had increased in size. An enlarged cervical node had been present for six months. In addition nodules were present on the skin of the left chest and the liver was enlarged. There was evidence of lung and splenic metastases.

The patient died six weeks after diagnosis and postmortem examination disclosed tumor masses in all tissues including brain, stomach wall and heart muscle.

The results in the thirty-nine cases traumatized by a physician are: death is known to have occurred in twenty-five; in twelve the result is either unknown or the cases are too recent for evaluation. On only two patients have survived an appreciable length of time. One of these was a six-year-old child who is well more than six years after excision. Such a result might well be expected because we have had no deaths reported in any children under the age of ten years. The other was a woman who had a subungual melanoma of the thumb. She is alive and well fifteen years after amputation of the thumb.

Although there is usually a story of irritation to a pre-existing mole by a stimulating agent over a considerable period of time, there are numerous instances where the lesions appear without any warning.

CASE II—One of us (J P W.) had such a lesion on his foot first noticed as a small coal-black flat dot which rapidly grew over a period of a month. It then attained a diameter of 2 mm. and was excised. On section this showed not the typical picture of a malignant melanoma but actually growing embryonic cells with mitoses that indicated possible very early malignancy.

CLINICAL AND PATHOLOGIC FEATURES

Malignant melanomas of the skin like the mole often show solid cords of cells but these are of larger size than in the ordinary benign mole. Mitoses are frequent and the nuclei are hyperchromatic. There

may be cuboidal cells giant cell formation or short spindle cells with the spindle cells frequently arranged in cords

The amount of *pigmentation* may vary As a rule there is very heavy pigmentation of an almost coal black variety while other melanomas are dark brown pinkish fawn colored or are wholly lacking in pigmentation These last are known as *amelanotic melanomas* The pigmentation that exists in all lesions may be in the tumor cells or in the adjacent chromatophores

One should be suspicious of a pigmented lesion of the skin which shows an unusual growth in extent and occasionally in height and an increased pigmentation especially if the area is subjected to repeated trauma Some lesions which have remained quiescent may show exceedingly rapid growth during pregnancy The appearance of increased vascularity of scales ulceration and bleeding are danger signs and irritation soreness itching or signs of inflammation indicate possible malignancy A spread of the pigment out from the edge of a mole into the surrounding skin as a pseudopod like projection as a shower of sootlike particles or as a halo around the periphery is indicative of invasion of the adjacent skin by malignant cells

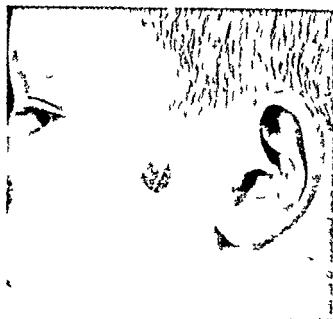
It may be possible that one or two of these symptoms or signs is sufficient to make a diagnosis but usually all of the factors of appearance and history have to be considered There are certain lesions usually of a pinkish fawn color noted in children giving the histologic appearance of malignant melanomas which even though previously traumatized in our experience rarely metastasize

CASE III—A McQ a six year-old white boy admitted August 16 1934 had had a small reddened elevated spot on his left cheek for three years No mole had preceded it The lesion measured 1 by 1 cm and had a brown zone around it (Fig 97 A) Several consultants believed it to be a keloid and radiotherapy was started On August 30 a biopsy was taken showing a melanoma and radical excision was done on September 28 1934 The regional nodes were not disturbed

The patient has remained well and no disease was discoverable at the last examination in December 1943 (Fig 97 B)

We have observed one case in a child aged eight years in which the lesion metastasized Following local excision in 1932 of a coal black malignant melanoma at the point of the shoulder metastasis occurred in the neck glands and pectoral skin After unnecessarily delayed excision with radical cervical and axillary gland dissection the patient is alive today ten years later without further recognizable involvement

CASE IV—M C an eight year-old towheaded girl had a raised oval coal black nodule on the left shoulder in May 1932 and a diagnosis of melanoma was made The parents thought it had appeared after a severe sunburn There was no history of a mole Excision was refused until December 8 1937 when considerable increase in size had occurred (Fig 98 A) It measured 13 by 20 cm and



A

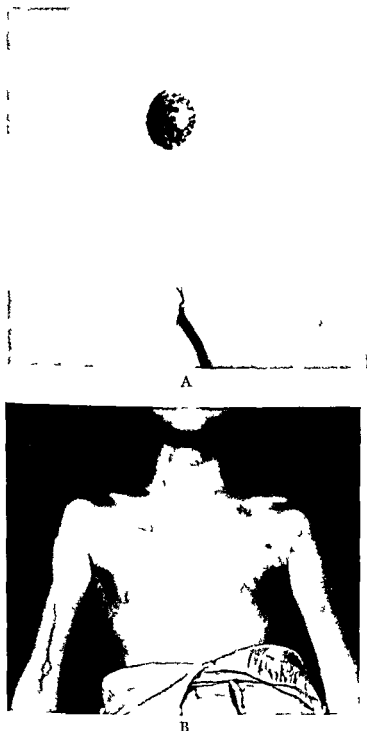


B

Fig 97 (Case III) —Lesion simulating a keloid in child who irradiated biopsy done by Parent. Still at least six years after radical excision of malignant melanoma. No regional node dissection.

A Condition September 28, 1934 after irradiation and biopsy

B Condition March 5, 1935 51 months after excision of the melanoma. Patient alive without recognizable disease in December 1943



A

B

Fig. 98 (Case IV) — Malignant melanoma of shoulder in a child aged eight. Permission for radical regional gland dissection delayed. Metastasis to anterior cervical node and skin of pectoral region. Three years later (1935) radical neck and axillary dissection. No reappearance nearly twelve years after lesion was first observed here.

A Condition December 8 1932 before local excision

B Infra red photograph May 1 1935 showing metastasis to lymph nodes in pectoral skin previous to excision and axillary dissection (See next page)



Fig. 98 (Continued) —C. Condition Oct. 6, 1933. No reappearance of disease by January, 1944.

was about 5 mm high. It was diagnosed as a melanoma after a wide excision locally with removal of the deep fascia.

Radical lymph node dissection was refused despite a subsequent palpable bluish lobulated nodule. Chest x-ray was negative and no melanin was present in the urine. Eventually permission was obtained for excision of the nodule under local anesthesia and on September 11, 1933, the node was removed. It had increased from 0.5 cm in diameter to 1 by 1.5 cm and was a black, firm, pigmented nodule of the melanoma type as the regional lymph nodes. On September 25, 1933, the black spots were noted on the skin of the pectoral region. Again the parents failed to accept advice to have the nodule plus the axillary nodes removed (Fig. 98 B). The child developed a chronic cough but chest x-rays and urine tests for melanin were normal. The subdermal nodules increased in size and the family consented to radical removal which was done in June, 1935. The pectoral nodules proved to be lymph nodes 60 percent replaced by tumor. All axillary nodes were clear. On September 3, 1935, a radical left cervical dissection was done where the lymph node with metastasis had previously been removed. No further lymph node involvement was found microscopically.

To date the patient has remained well and has developed normally. She is now twenty years old, married, and shows no reappearance of the lesion almost twelve years after its initial occurrence.

Malignant Freckles—There is a type of lesion which is usually quite dark or even black, lying in the upper layers of the skin with little or no elevation. Such lesions are known as malignant freckles. They



A



B

Fig 99 (Case V) - Malignant freckle. Started during pregnancy as mole seven years previously, rapidly enlarging after being scratched eight months before admission.

A Condition March 1935 before excision and upper deep cervical node dissection. The defect was closed by utilizing adjacent skin flaps.

B Condition January 9 1937. Patient free from disease March 13 1944.

spread peripherally and have to be treated radically since they are true malignant melanomas

CASE V—A small light brown mole on the left side of the face was first noted by this forty-eight year old patient (E. L.) seven years prior to her admission in March 1935. It appeared during pregnancy. The mole slowly enlarged until August, 1934 when it was accidentally scratched. It then began to enlarge rapidly. An irregular brownish black area 3 mm in diameter was present and a dark red elevated nodule was present near the posterior border (Fig. 99 A). No node could be felt.

A wide excision was done March 2, 1935 which included the deeper deep cervical nodes and the wound was closed by an adjacent flap. The lesion proved to be melanoma—a so-called malignant freckle. Lymphatics were perfused with out cervical metastases. The operative result is seen in Fig. 99 B.

The patient was well and apparently free of disease nine years later.

Metastasis—As regards extension of growth the malignant melanoma may spread peripherally into the skin or may have daughter lesions appearing in the skin at some distance from the original lesion. Metastases usually appear in the regional lymph nodes at an early date followed by scattered lesions over the body surface with subsequent invasion of the lungs and other organs. No organs may be spared in the final stages of the disease. Melanuria may then be present but may also be found with only a slight distribution of the lesions.

DIFFERENTIAL DIAGNOSIS

There is a considerable number of other lesions many of which are innocuous or comparatively innocuous which may simulate the malignant melanomas and which are a problem in diagnosis and treatment. The diagnosis of these lesions without microscopical examination is frequently so difficult as to baffle men of wide experience and even expert pathologists have difficulty in classifying the histologic appearance of some of these lesions.

Benign Hairy Moles—Particularly difficult is it to differentiate between the mole that is innocuous and that which may of itself or by stimulation become malignant. As a rule the fairly large congenital pigmented hairy mole of light brown color does not become malignant when stimulated by incision or even by repeated applications of carbon dioxide snow. Such lesions treated by the snow method have often been caused to lose their elevation and much of their pigmentation but the hairs are not affected by this treatment and remain as a deformity if on an exposed surface. Scarring and contracture may also result from this method of treatment.

A slightly elevated light brown pigmented hairy mole of the cheek was seen by one of us. There was a story of recent increase in size and height of the mole with pain and redness. The history was obtained that the patient was in the habit of pulling out the stiff hairs

from the mole to make it less unsightly. While we felt that this procedure had caused irritation to the hair follicles there was nevertheless a suspicion of malignancy. The area was widely excised and an infected cyst was found beneath the mole with roots of hairs protruding into the cyst.

Blue Nevus—The so called blue nevus is a separate type of lesion commonly appearing about the upper extremity and the head and we have found it especially frequent on the nose. There may be a history of its presence since birth or early childhood but also of sudden appearance in a child so that the parents may feel that the child's skin has been punctured by a pen or pencil. We have seen no melanomas developing from these nevi even if traumatized. We have had thirty three cases with the following *distribution*

Upper extremity	18
Head	10
Back	
Lower extremity	3
Perineum	1
Total	33

Darier¹ has reported three instances in which these blue nevi became sarcomatous but the sarcomas were of such a benign nature that excision of the lesion eliminated all danger of reappearance or metastases. We have had one such case pictures of which are shown in the text book of Dr. Andrews.

Miscellaneous—As noted above melanomas of children may be confused with *keloids*.

The *seborrheic wart* frequently simulates a malignant melanoma with its increase in size, scaliness and often ulceration and bleeding. Its fissured surface seen under magnification usually distinguishes it from the melanoma however.

We have known of a case in which a *pigmented papilloma* was thought by others to be a malignant melanoma and a very radical operation was advised. A lesion of this type may become infected through maceration of adjacent skin surfaces but the history and benign appearance of the papilloma should distinguish its innocuous growth.

Some of the pigmented areas of neurofibromas of *von Recklinghausen's disease* have been diagnosed as malignant melanomas. There may be difficulty at times in distinguishing *Bowen's disease* and the pigmented basal cell epitheliomas from melanomas. If the mass of evidence is on the side of Bowen's disease or epithelioma a biopsy is justifiable and should determine the exact nature of the condition.

An amelanotic melanoma may be mistaken for a *sebaceous cyst*. If such an apigmented lesion should appear in the vicinity of a suspicious looking pigmented lesion especially with a history of trauma to a



A



B

Fig 100 (Case VI) — Malignant melanoma following inadequate excision spreading dorsally and medially to ala having an apogonized stellate umbilical sebaceous cyst and subsequent carotid node metastasis. With local excision and rotation of cheek flap and subsequent delayed radical neck dissection. Patient well 5 years later.

A Condition before operation July 13 1937. A scar and pseudopod-like projection into skin below which is an pigmented nodule. Patient refused neck dissection until March 5 1938. In one large carotid node showed metastasis.

B Condition April 28 1941 showing result of rotating cheek flap into the peritonsillar defect which included a portion of the larynx. Also showing result of neck dissection.

mole one should treat the two areas as part of one process. Such a case occurred in our experience.

CASE VI—N. C., admitted July 17, 1937, was a fifty-year-old woman who had had a small pigmented area on her left cheek for four and a half years. It had been partially removed by cautery by a physician. The lower margin then became more deeply pigmented and spread downward together with a shower of black particles scattered medially to involve the base of the left ala.

There was a tiny nonpigmented area in the skin 1 cm. below the margin suggesting a sebaceous cyst (Fig. 100 A).

A wide excision was done on July 15, 1937, and the defect closed by advancing a cheek flap. The prognosis was judged to be poor because the remote nodule proved to be an amelanotic malignant melanoma. Node dissection was refused at this time.

Seven months after discharge the patient returned with a large firm carotid node. A radical neck dissection was done March 5, 1938. This node was large and involved the platysma. Out of 33 lymph nodes removed and examined it alone showed metastatic melanoma.

She is living and well today, six years after the radical neck dissection (Fig. 100 B).

We have ourselves been deceived by a lesion of *traumatic* origin.

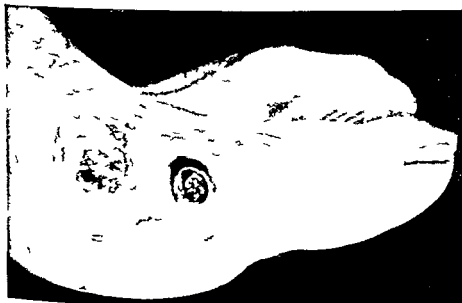


Fig. 101 (Case VII)—Traumatic lesion of two months' duration simulating a very rapidly growing malignant melanoma. Starting as a yellowish white waxy nodule two months previously, it became reddish purple and then black, with black peripheral irradiations. Before radical excision was made the character changed indicating its true nature—hemorrhagic vesicle.

CASE VII—This lesion occurred on the side of a great toe. There was a history of a very rapid onset and a rapid growth over a period of two months. When seen the lesion was 1.5 cm. in diameter, smooth, raised, bluish black, having a distinct halo of bluish black pigmentation extending radially outward into

the skin from its entire periphery (Fig. 101). A radical operation as advised at an early date because the rapidity of growth indicated extreme malignancy. Ten days later when operation was about to be performed a difference in appearance was noted. It then resembled a large blood blister. By aspiration bloody serum was obtained and the diagnosis of traumatic hemorrhagic eczema was definitely made. The history revealed that the patient had been much on his feet and that pressure from badly fitting shoe had been repeatedly exerted at this spot. After removal of the lesion the wound healed in a few days with verotrim dressings.

It is important to differentiate between the various nonmalignant lesions and those that are malignant or may become so either spontaneously or when activated by stimulation. The treatment of both the latter conditions consists in complete excirpation of the entire lesion.



Fig. 10 Multiple congenital yellowish brown moles on trunk, body and dark brown nevus and neurofibroma of back.

There must be no compromise with these conditions and complete eradication must be brought about at the time the lesion is first treated.

There are of course many moles which never become malignant tumors even if traumatized or incompletely removed. It would be impossible to attempt to remove all of the moles which cover the skin surface of some individuals nor is it necessary for in such cases the moles rarely become malignant (Fig. 102).

The difficulty is that it is not possible to know in any given case whether or not an apparently quiescent innocuous mole will become



A



B

Fig 103 - Malignant melanoma started as congenital warty growth which began to grow and was inadequately removed by electrodesiccation. Extension to cervical lymph nodes treated by intensive radiotherapy which caused necrosis and erosion of great vessels with which patient died.

A Condition after inadequate electrocauterization

B Condition after radiotherapy before extensive ulceration occurred

a malignant melanoma if subjected to trauma or incomplete removal. The statistics already presented at the beginning of this paper show conclusively that the death of the patient may be the result of any form of treatment which fails to remove every mole cell.

TREATMENT

There are three methods of eradication which may be considered: irradiation, cauterization and surgical excision.

Irradiation—As a rule, irradiation is ineffectual in the treatment of malignant melanomas since these lesions are usually radioresistant (Figs 103 A B). We had one patient, a woman who when seven months pregnant complained of a rash on her back of six weeks' duration. This centered around a mole which had been present all her life. There was inflammation, marked itching and rapid growth. Multiple satellites of pinkish fawn color were scattered over a wide area on her back surrounding the black mole (Fig 104 A). This was evidently a nonoperable condition. She received heavy irradiation after biopsy proved it to be a malignant melanoma. The itching and the number of satellites increased (Fig 104 B). She suffered intense pain requiring morphine until her death about fifteen months later.

On the other hand, we have one patient who had a nodule appear on his chin which had been cut two years previously while shaving. This nodule was supposed to have been 'burned off' by his family physician and was given diathermy treatments. There was an elevated scar slightly more than 1 cm long surrounded by firm, flesh-colored nodules (Fig 105 A). Radiotherapy by Dr. Andrews caused the lesion to flatten out with no palpable cervical nodes developing (Fig 105 B). The lesion was widely excised four years ago and the patient is now still free from recognizable involvement.

Cauterization—Cauterization has been advocated as an ideal method of treatment. It has advantages in that the procedure takes but little time, is comparatively inexpensive and requires little skill to perform, although much education is needed to have it understood by the profession that the cauterization must be sufficiently radical to destroy the entire lesion and must include a generous margin of normal tissue.

On the other hand, cauterization causes wounds to heal slowly, especially if they are of considerable extent. It produces a granulating wound which remains open and discharges secretions for a long time if the area is at all extensive. The wound requires many dressings and the final result is an unsightly shiny scar that not only may not match the surrounding skin but by contraction of the scar tissue may distort the surrounding parts, such as the eyelids and lips. Moreover, with cauterization there is no positive proof that the lesion has been completely eradicated—only the negative proof if in the course of time the lesion fails to reappear. Neither the patient and his family nor the physician has any satisfaction in waiting for that kind of proof.



A



B

Fig 104—Malignant melanoma of back greatly activated during pregnancy with rapid spread and itching Being considered inoperable it was irradiated unsuccessfully and produced marked ulceration Death occurred

A Condition at seven months pregnancy

B Condition after primary irradiation



A



B

Fig 105—A nodule arising from a melanocytoma was excised by a physician and recurrence treated by radiotherapy. Radiotherapy produced the lesion so that surgical excision was possible.

A Condition before irradiation

B Condition after irradiation. Despite histological diagnosis of malignant melanoma the patient was well nineteen months later.

to be established. There is always present the dread of the sword of Damocles. With cauterization no immediate closure is possible and no plastic repair can be instituted until the wound is healed and all inflammatory processes have subsided.

Radical Surgical Excision—We believe that radical surgical excision offers the best therapy for all of these lesions. Immediate closure is possible and immediate plastic repair can be made either from the surrounding tissues or with skin taken from a distance as free grafts or pedicle flaps if the surgeon is skilled in the various plastic procedures. In this way with immediate closure all raw areas may be covered over with skin so that no dressings are required after a week or ten days for the smaller lesions and two or three weeks for the more complicated lesions. The scars may be quite inconspicuous and but little deformity may result even though a wide area of tissue has been removed. Certainly the final result is usually much less conspicuous than was the original lesion.

There is moreover a tremendous advantage in the method of radical surgical excision as compared with that of destruction by cautery in that *an opportunity is given to examine the lesion microscopically*. One can determine in the first place the exact nature and characteristics of the lesion and in the second place can make certain that all of the lesion has been excised with a sufficiently large margin of safety by cutting sections from the various parts of the specimen and studying the tissues microscopically. Such an histologic study has another advantage in determining whether or not it is advisable to perform a subsequent radical excision of the regional lymph nodes.

It must be understood that whether cauterization or excision by the scalpel is carried out the area destroyed must be sufficiently wide of the lesion to make certain of *complete* eradication of every malignant cell the first time the local lesion is attacked. Otherwise subsequent procedures may prove of no avail because of the spread of malignant cells beyond the local area.

We are not accustomed to excise the lesions with the *electric knife* since we prefer to take a sufficiently wide margin of normal skin and subcutaneous tissue to insure complete removal of the lesion and obtain the better healing that results with use of the scalpel.

Biopsy—With the smaller suspicious looking lesions we feel that a biopsy excision with plastic closure of the wound is indicated. As regards the larger or more definitely melanomatous lesions we believe it inadvisable to remove tissue for biopsy for the reason that such a procedure may cause spread of the tumor cells before permanent sections can be made. It is difficult to make a certain diagnosis of malignancy by frozen section therefore radical excision with the removal of a wide amount of skin and subcutaneous tissue is generally indicated.

Plastic Procedures—There are various plastic procedures available to

fit each individual situation. One has to take into consideration all of the individual factors such as the size and location of the lesion and the character of the skin involved, keeping in mind its thickness, color, hairiness and the number and size of the pores. Better cosmetic results are usually obtained by using the skin from adjacent areas to close the operative defect than if tissue has to be brought in from another part of the body.

If the lesion is small, an elliptical excision with the longitudinal axis in the direction of Langer's lines of skin tension, undercutting on either side to sever the connective tissue fibers which pass from the skin through the subcutaneous fat to the deep fascia, will allow for a closure of the cut edges of skin and subcutaneous tissue so that almost no deformity may result.

If it is necessary to cover the defect with tissue from a distance, *pedicle flaps*, either simple or preferably tubed, may be used with an attempt to obtain the best match of skin possible. Some lesions may be so large that an extensive defect is left after excision. *Free skin grafts*, either of split or full thickness skin, may then be used to advantage. With these free grafts, however, there tends to be a depression inasmuch as the subcutaneous tissue is not replaced by this procedure. These free grafts of skin tend to produce more contraction than when the defect is closed by using the adjacent skin or pedicle flaps which contain both skin and subcutaneous tissue.

It is evident that the surgeon excising these lesions should be familiar with the various plastic surgical procedures available to bring about the most satisfactory cosmetic result. It is more important today than ever before that there be as little detraction as possible from the patient's normal appearance, as his happiness and livelihood may depend upon it. For this reason every effort should be made to prevent undue scarring by the operative procedure. Such scarring may be caused by insufficient nourishment to the pedicle flap or free skin graft or by the use of large and tight sutures which cut into the skin and make permanent marks on either side of the line of closure, thus increasing the resultant deformity.

Subungual Melanoma—For the subungual melanoma, amputation of the digit should be performed, removing a sufficient length of the digit to insure eradication of the disease. There may be better function and appearance if the entire digit with a portion of the metacarpal or metatarsal bone is excised.

Radical Regional Lymph Node Dissection—The decision regarding radical regional node dissection is based upon the preoperative and microscopic appearance of the lesion, thus widely excised, and upon the history. If the surgeon is certain of the malignancy of the tumor, the excision of both the lesion and the regional lymph glands may be made at the same operation. One should not, however, combine both procedures if they would take so long as to endanger the life of the

patient. If for this or any other reason such as the danger of infection the lymph nodes are not removed at the same time as the primary lesion they may be removed later but with as little delay as possible because each day of delay makes the likelihood of cure more remote.

If regional gland dissection is carried out it should be performed with the utmost thoroughness and care removing in a block all of the regional lymph nodes with their surrounding fat blood vessels and connective tissue. The tissue should be traumatized as little as possible and bleeding points should be tied with the finest ligatures and tissues closed with the finest suture material adequate to maintain closure. By this procedure and by an optimum amount of pressure by dressings satisfactory hemostasis may be obtained and the wound be kept from filling with blood and serum. Accurate approximation of the subcutaneous tissue and skin without undue tension from the sutures together with satisfactory hemostasis may bring about healing per primam with no edema of the part even though not only the lymph glands are radically excised but the main veins as well. With this technic it is possible to perform a thorough radical inguinal gland dissection without resultant edema of the leg. Such a freedom from edema is very desirable because chronic edema not only may be unsightly but may impair the function of the extremity.

SUMMARY AND CONCLUSIONS

- 1 The diagnosis of malignant melanoma is often difficult and requires expert opinion.
- 2 A large percentage of malignant lesions arise from moles that have been stimulated by the patient or by a physician.
- 3 Complete eradication of all suspicious looking lesions and malignant melanomas should be carried out.
- 4 Irradiation is usually ineffectual.
- 5 Radical surgery is preferable to cauterization.
- 6 Depending upon the history and histologic examination of the lesion radical regional lymph node dissection should be performed.
- 7 The surgeon performing the operation should have a knowledge of the procedures of plastic surgery.
- 8 In the excision of malignant melanomas it should be emphasized that *thoroughness of the procedure* is the first aim of the surgeon and that inadequate removal of the lesion endangers the life of the patient and that the appearance and function of the part are of secondary importance. One cannot afford to compromise with this disease.

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DEPRESSED FRACTURE OF THE ORBITAL RIM

With the Report of a Case Treated by Reduction through Caldwell Luc Approach with Maintenance of Position of Fragment by a Water Inflated Balloon

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FRACTURES which involve the rim of the orbit have been referred to in the literature as fractures of the malar zygomatic compound malar bone fractures fractures into the antrum and by various other terms Any blow which is strong enough to displace the malar bone very often results in a multiple type of fracture in which the entire malar bone is displaced or subluxated as its supports give way The malar bone itself is a relatively solid structure The suture lines which unite it to the frontal process of the maxilla medially to the zygomatic process of the temporal bone posteriorly to the frontal bone superiorly and to the body of the maxilla inferiorly are more readily separated or fractured than the bone itself The malar bone makes up a sizeable portion of the floor of the orbit and the inferior and lateral orbital margins A depressed fracture of the orbital rim as in the case report to follow mainly involves this bone

There are numerous methods which have been described repeatedly in the literature for reducing malar bone fractures all of which involve the principle of elevating the fragment into position by manipulation The classical means of accomplishing this manipulation have been largely by the use of a large tenaculum a hook or pressure with a blunt elevator intra orally or by using the Cillies temporal approach with a blunt elevator or by attachment of a screw to the bone through a small skin incision

An x ray picture of a fracture into the antrum usually shows cloudiness which is ordinarily the result of hemorrhage into this cavity and should not be construed to mean infection Infection occasionally results however in cases in which the natural ostium is blocked and drainage of the sinus cannot be accomplished in the usual manner or in which the fracture occurs in a patient having subacute suppurative maxillary sinusitis

Under ordinary circumstances by the end of a two to three week period of watchful waiting the clot which formed in the hemio-antrum will have been hemolyzed and removed by the action of the ciliated epithelium lining the normal antrum through the natural ostium the regular avenue of drainage The treatment that interferes the least with normal functions is the best for a case of hemio-antrum The use of some drug for nasal shrinkage such as 1 per cent ephedrine

or 0.25 per cent neosynephrin in normal saline should be the extent of therapy. Surgical intervention including antrum lavage is reserved for complications only.

When dealing with the ordinary maxillary bone fracture one can reduce it so that the bony fragments will stay in place mainly because there is no large muscle attached to it which would pull the bone out of alignment. If however the bone is *comminuted* an entirely different problem presents itself. If the fragments are completely separated from the surrounding supporting structures even complete reduction may not insure retention of these fragments in their proper position.

From the standpoint of the ophthalmologist great emphasis should be put on the perfect alignment of the floors of the orbits not only for cosmetic reasons but also for the purpose of preventing vertical muscle imbalances. It is much simpler to prevent hyperphorias at the time of the reduction of the fracture than it is to repair such a deformity at a later date by using cartilage implants.

A comminuted fracture of the rim of the orbit may have a fairly large fragment depressed into the antrum. Some means of holding this fragment in place is necessary until fibrous union has occurred. The three most common methods used in such instances are (1) the use of a dental drill in an open reduction with actual wiring of the fragments into place (2) the use of a screw attached to a head cap by some means of traction and (3) the use of the *Caldwell Luc approach* to the antrum followed by packing of the antrum with either petroleum jelly or iodoform gauze. In the last method the packing is left in place until a fibrous union between the edges of the fragment and the surrounding tissues is strong enough to hold it in place. The packing may be removed in one of two ways—either through the original incision in the canine fossa or through the window in the inferior meatus made at the original operation, the mouth incision being closed. This latter method of removal appeals to the writer as the more desirable procedure. By the time the packing can safely be removed the original incision in the buccal mucosa has completely healed.

In the case report being presented the Caldwell Luc approach was used but the procedure was modified by a simpler method of packing to hold the fragment of the orbital rim in position.

CASE REPORT

F. G., a white soldier aged thirty-four years, was admitted to the Station Hospital at 7:30 A.M. October 10, 1943. He had been hit on the face during a fight at a party for noncommissioned officers. Examination showed marked ecchymosis and edema of eyelids of both eyes, a laceration of the right upper eyelid, a depressed fracture of the left superior maxilla, a hump deformity of the nose to the left with a marked depression of the left nasal bone and point tenderness over the rim of the orbit in the region of the zygomatic suture.

The laceration of the right upper eyelid was sutured under 1 per cent procaine infiltration anesthesia and the patient because of the severity of the head injury admitted to the hospital and treated as one having a possible brain concussion. While in the hospital no improvement in neurological examination showed no demonstrable evidence of concussion. X-rays were taken. These showed a fracture through the posterior portion of the zygomatic arch with very little displacement of the fragments. Although the bony margin of the left



Fig 106—X-ray of the skull, October 12, 1943, showing fragment depressed into antrum.

maxilla in the region of the frontal process of the maxilla the comminuted and displaced fragment of the zygomatic arch and the nasal bone comminuted with marked depression of the left (Fig 106). The left maxillary sinus is filled with opacity probably denoting a hemothorax.

Five days later with 10 per cent cocaine applied topically, intranasally and 2 per cent procaine infiltration anesthesia externally along the base of the nasal bones the depressed left nasal bone was elevated and the hump deformity reduced with ease. Postoperative X-ray study

showed the nasal bones to be replaced in their normal positions with no appreciable change in the fragment at the infra orbital margin. The nasal splint was still in position.

By October 20, 1943, as the edema subsided and the ecchymosis was absorbed, the depressed fracture of the orbital rim became more apparent. The patient complained of some blurring of vision in the distance. A visual check showed 20/20 bilateral vision but the muscle balance showed 5 diopters of right hyperphoria in the distance.

On October 29, 1943, under block anesthesia for the maxillary division of the fifth cranial nerve using 2 per cent procaine and sphenopalatine block anesthesia intranasally with cocaine, an incision was made in the region of the left canine fossa for the usual Caldwell-Luc approach to the antrum. When the periosteum was elevated, the bone below the infra orbital foramen was found to be fragmented and depressed into the sinus. These pieces were removed and the intrum membrane opened. Foul smelling pus and necrotic masses of old clotted blood were removed; a culture was taken from the pus inside the sinus and the entire mass of necrotic membrane which lined the



Fig. 107.—The balloon and catheter used inside the antrum to elevate the depressed fragment of the orbital rim.

left antrum was removed. The intranasal antrum window approximately 2 cm long was next made in the inferior meatus. At this time the block of tissue which contained the loose bone fragment needed to complete the rim of the orbit could easily be elevated into its normal position but would drop down as soon as the instrument used for elevating it was removed. Since there was no supporting structure upon which the fragment could be impacted, some other means for holding it in place had to be devised. To offset the infection already present, approximately 2 gm of powdered sulfanilamide was placed inside the antrum.

From this point on the treatment was varied slightly from the usual procedure. A small balloon made from the finger of a rubber glove to which a portion of a No. 14 rubber catheter was attached (Fig. 107) was introduced into the antrum through the opening in the canine fossa. A small curved forceps was introduced through the left nostril and antrum window; the catheter grasped and brought outward and left to protrude from the left nostril. The incision in the buccal mucosa

of the canine fossa was closed with interrupted black silk sutures. Approximately 10 cc of water was put into the balloon through the catheter the end of which was doubled on itself and tied with heavy black silk to prevent leakage. At this time the fragment of bone at the rim of the orbit appeared to be in perfect alignment. The patient was sent for recheck x rays (Fig 108) and then returned to his ward.



Fig 108—X ray taken October 29, 1943, immediately after a trussing. The position of the fragment is not the same as on first x ray.

On the day following the operation, x ray study revealed very little change in the position of the loose fragment from its original depression. One half hour after the patient had received $\frac{1}{4}$ grain of morphine by hypodermic, an additional 10 cc of sterile water was introduced into the balloon through the catheter. During this procedure

the depressed portion of the orbital rim could be seen to rise and on palpation seemed to be in good position. The catheter was again bent double and tied with heavy silk suture. Recheck x rays showed the fracture fragment to be elevated into satisfactory alignment (Fig 109).

On November 3, 1943, following the introduction of the additional water into the balloon, the patient complained of pain which necessi-



Fig 109—X ray taken October 30, 1943, after an additional 10 cc of water had been put in balloon. Fragment elevated to more satisfactory position.

tated morphine for its alleviation. The face was less edematous and the appearance of the patient was much improved. At this time the sutures were removed from the incision in the buccal mucosa.

Approximately three weeks after the introduction of the balloon into the antrum, the patient was able to be up and about in the ward and complained of no nasal discomfort. The catheter was clamped off and the silk suture removed. The water was then allowed to run out grad-

ually until the balloon was deflated. The entire balloon and catheter combination was easily removed from the nose through the intranasal window. The nose showed very little reaction. X ray study at this time showed satisfactory alignment of the fragments along the infra orbital margin with no evidence of bony healing and the left antrum almost completely cleared of the opacity noted on previous plates (Fig. 110).

By November 22, 1943, the patient had no complaints. His facial contour was equal bilaterally, vision was 20/20 bilaterally with mus-



Fig. 110 X ray taken November 19, 1943, after removal of balloon shows satisfactory alignment of orbital margin.

cle balance showing orthophoria for distance and 6 diopters of exophoria with 1 diopter of right hyperphoria measured at 16 inches. Examination of the nose showed adequate air space in both nostrils, no purulent discharge, and the left antrum window still patent. The patient was discharged from the hospital.

A recheck in the Eye, Ear, Nose, and Throat Clinic on December 9, 1943, indicated a satisfactory result; the patient having no complaints and the infra orbital rims of both orbits apparently on the same level.

Laboratory Reports October 11 1943 Urinalysis normal red blood cells 4116,000 hemoglobin 85 per cent white blood cells 8656 Differential polymorphonuclear cells 72 per cent eosinophils 3 per cent monocytes, 8 per cent lymphocytes 1/ per cent Sedimentation rate 19 mm in one hour Kahn test, negative

November 3 1943 Culture from left antrum shows bacillus of coli aerogenes group and an encapsulated diplococcus resembling pneumococcus was isolated Pneumococcus like organism did not type

November 9 1943 Sulfathiazole level 3 mg per 100 cc Urinalysis normal

Comment—A case which involved a fragment of the bony orbital margin depressed into the antrum is reported A water inflated balloon inside the antrum was used to hold the fragment in position A satisfactory cosmetic and functional result was obtained

The idea for the particular treatment used in this case grew out of a statement made by Dr Marvin F Jones in a course given by him at a meeting of the Academy of Ophthalmology and Otolaryngology in which he suggested the use of an inflated balloon as a means of preventing or controlling postoperative hemorrhage in sinus surgery Considering the simplicity of application this treatment should find other types of cases in which it could be used to good advantage

VERTICAL SHORTENING DEFORMITIES OF THE EYELIDS PLASTIC AND RECONSTRUCTIVE SURGICAL COR RECTION

DANIEL B. KIRBY, M.D., F.A.C.S.

IN THESE days of warfare the importance of injuries to the eyes and eyelids can scarcely be overemphasized. In 1947 with A. E. Town I published an article on "Injuries of the Eyes and Eyelids" ¹ but space did not permit of sufficient detail on the plastic and reconstructive surgical correction of the eyelid defects. More attention will be given now to some of the important traumatic and cicatricial conditions of the eyelids requiring repair—which may be grouped under the heading

Vertical Shortening Deformities of the Eyelids. I have had the privilege of training under the great ophthalmic plastic surgeon John M. Wheeler ² who had so much experience during and after the first World War and will frequently refer to the classic and original techniques which my preceptor developed.

PRELIMINARY CONSIDERATIONS

The Subject—Vertical shortening of the eyelids implies a defect, a loss of tissue which results in deformity: either inversion (entropion), eversion (ectropion), ptosis, epicanthus, adhesion of lid tissues previously mobile to fixed tissues such as periosteum or to less mobile tissues such as the brow or the upper cheek (ankyloblepharon), absence of tissue (coloboma), shallow or absent conjunctival cul de sac, exposure of the eye (lagophthalmos), adhesion of lid to globe (symblepharon), et cetera. The cause may be congenital maldevelopment or trauma, either by laceration or contusion with or without necrosis, debridement, inflammation or sloughing of tissues. Colobomata of the eyelids may also be produced by surgical excision of neoplasms or cicatricial tissue.

Surgical Anatomy—An accurate knowledge of the surgical anatomy of the eyelids is important. The thickness of the lids, their length, vertical measurements, attachments to the canthi, the action of the orbiculars, particularly in relation to the lacrimal sac, the levatores palpebrarum, the smooth muscles of the eyelids, the attachments of the fasciae of the superior and inferior rectus muscles, the tarso-orbital

From the Department of Ophthalmology, New York University College of Medicine and Bellevue Hospital. The author is indebted to Dr. John H. Dunning for permission to publish this illustration, secured from the Art and Photograph Departments of the Institute of Ophthalmology of the Presbyterian Hospital, New York City.

Professor of Ophthalmology, New York University, and Senior Surgeon, Chief of Ophthalmology, Bellevue Hospital, College of Surgeons, New York, and Ear, Infirmity and Manhattan Eye and Ear Hospital.

fasciae the special nature of the skin within the area of the orbital margins the relations of the eyelids to the eyeball in motion as in the acts of winking opening and closing the eyes looking upwards and downwards the vertical width of the palpebral fissures with the eyes level eyes up and eyes down and the horizontal measurement both by straight line along the canthi and by curved line along the lid margins all are details a thorough knowledge of which will help the ophthalmic plastic surgeon He should train himself to make accurate observations and drawings and not rely on photographs which often are quite deceptive except when taken in stereoscopic relief

Physiology—The functions of the eyelids must not be lost sight of in plastic or reconstructive surgery These functions and not the cosmetic effect are the most important end results A harmonious blending of both is most desirable The maxim Never add a deformity in correcting a deformity has a very definite application in repairing eyelid defects

The importance of the eyelids as the mobile curtains for closure of the eyes and as the smooth surface of the palpebral conjunctiva over the bulbar conjunctiva and cornea and their importance in the carrying of moisture from the lacrimal glands and the oily protective film from the eyelid margin glands are appreciated best by the ophthalmic surgeon who has had special training in eye and plastic surgery He should be the one selected to do such surgery of the eyelids for it is he who has special knowledge of the physiology of the eyes themselves although in emergency situations effective procedures may be carried out by any capable surgeon

Principles of First Aid in Injuries of the Eyelids—The protection of the cornea and of the conjunctiva the avoidance of infection the avoidance of debridement except where necrosis and sloughing is evident and imminent even though the eyelid tissues are severely contused suturing in correct position where possible the complete examination and treatment of the eyeball itself the appraisal of any injury to the eye in terms of sympathetic ophthalmia the care of the general system the use of prophylactic agents against infection all have their place in first aid to eyelid injuries in civilian and military life

Anesthesia—If not contraindicated plastic procedures are more easily performed under general than under local anesthesia because of the necessary and difficult infiltration of injured or diseased tissues Where local anesthesia is used the principles of infiltration and of block of the supra orbital and infra orbital nerve should be used Adrenalin in small quantities may be added to the novocain used for infiltration

PRINCIPLES IN PLASTIC AND RECONSTRUCTIVE SURGERY OF THE EYELIDS

If the cornea is not protected operate early for the conservation of the cornea and the integrity of the eyeball and for the preservation of vision If the eyeball is safe operation may be delayed until

complete resolution of fibroblastic tissue has been accomplished. Fresh scar tissue is fragile and nonplastic and operative trauma at this stage produces further fibroblastic tissue. The maxim "Never add a deformity in correcting a deformity" may well be repeated. In all plastic and reconstructive surgery of the eyelids the integrity and formation of the eyeball should have first consideration.

Plan of the Operation—Logical and practical plans for the plastic reconstruction should be made. Bizarre or fantastic operations have no place in plastic surgery of the eyelids. Think first of the safety and function of the eye when planning plastic or reconstructive operation on the eyelids.

The Local Examination and General Survey of the Patient—The general condition and the relation of the ocular and orbital injury or condition has much to do with the plan for the reconstructive surgery of the eyelids. When the general condition is precarious and the prognosis for recovery is doubtful, then the eyelid treatment, except for the conservation of the eye itself, is subservient to that to the general condition.

If the eyeball itself has been injured and there is any danger of sympathetic ophthalmia, the injured eye had better be removed before attempting any plastic or reconstructive procedure on the eyelids.

If the lacrimal sac is infected, as it often is in deep injuries with fractures involving the nasal or orbital bones, the infection of the sac must be cleared before the plastic procedure is begun.

The Handling of the Tissues of the Eyelids—It must be realized that there is only a limited amount of tissue in the eyelids and particularly in the lid margins. Every millimeter is essential. The tissues, particularly of any graft, whether with pedicle or free, should not be traumatized. Instruments should not be used on the tissues needlessly. The bed prepared for the graft should not have exposed ligatures. Oozing blood vessels should not be tied off. The bleeding from these can be controlled by a firm pressure dressing. Spurting arteries may be clamped until closure of the vessels is effected, after which the clamps are carefully removed. The application of hot water sponges is not advisable because they lower the vitality of the tissues. Particularly the free graft of skin should not be subjected to heat. It will survive better if kept moist with saline at room or body temperature than if placed in solution of higher than body temperature.

Sharp small cutting, preferably atraumatic needles with fine silk thread, lightly lubricated with petrolatum or a mixture of 3 parts petrolatum and 1 part white wax, are best for easy suturing to the surrounding skin.

Suturing must be arranged so that the tissues are not put under tension. X-ray therapy may be used where there is tendency to keloid or productive scar tissue reaction.

Tissues from the eye and orbital region should be used wherever

possible in reconstruction of eyelids. Conjunctival free or sliding grafts are preferable to buccal membrane grafts for lining the inner surface of the eyelids. Skin lining of the lids to replace conjunctiva is undesirable because of the nature of the tissue.

Skin of the orbital and temple areas is particular and individual in character, thickness, absence of hair and glands. If at all possible, free transplant of such full thickness skin from normal areas to the deficient area offers the best match in color and texture.¹⁸ Next best is the skin from behind the ear in the cephalo auricular angle (Fig. 111) and lastly the tissue paper thin epidermal graft from the thigh. A sliding pedicle graft from the temple area is excellent for certain color blemishes. Full thickness pinch pedicle, tubular, twisted or sliding grafts

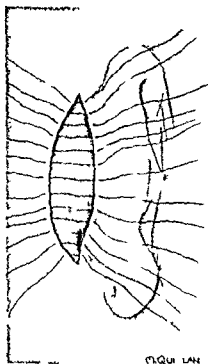


FIGURE 111

Fig. 111—Technic of removal of free dermic graft from the cephalo auricular angle.

from the brow, cheek, arm, neck, or other regions are unsatisfactory and undesirable because of their excessive thickness, color, contour, texture, lack of conformation, and plastic character. They add unnecessary deformities.

The preparation of the bed or underlying tissue for the graft is very important. Subcutaneous sliding grafts of tissue may, if indicated, be brought into position without tension from the areas surrounding the eye. In case of defect of the lower lid, the inner half of the upper lid may be placed as the basis for reconstruction of the lower lid.

The deep bed around the eyelids may be deficient as a result of deep injuries or necrosis in the orbit or orbital margins. In such cases

filling of holes with fascia lata or a transplant of cartilage fat or other material may be in order before the eyelid can be properly reconstructed.

Adhesion of the lid to the globe or the extrinsic ocular muscles offers especially difficult problems. To free the globe and muscles from the lid tissues the interposition of a graft of Tenon's capsule according to Berens¹ technic to provide a proper medium of separation so that the muscle may function is necessary.

Closure of the Lids—The lids must be closed accurately as the basis for a proper dressing after a plastic or reconstructive operation on the eyelids (1) to immobilize the parts (2) to protect the eye (3) to prevent hemorrhage and transudation and (4) to keep the tissues and graft in apposition and thus promote healing. These purposes may not be accomplished simply by closing the eyelids. Temporary suturing

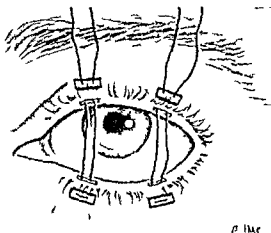


Fig. 112—Technic of intermarginal lid adhesions.

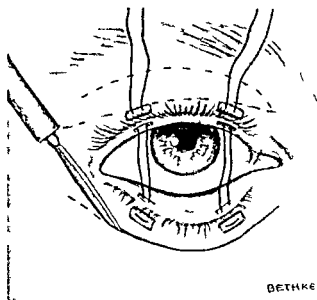
between the lid margins making sure the lashes are in proper position or in cases involving large areas of the lids intermarginal lid adhesions should be used.

The Technic of the Intermarginal Lid Adhesions (Figs 111-113)—The lid margins are placed in apposition after dissection of the lids has made them free from tension. Suitable places for adhesions are chosen along the lid margins. It is not practical simply to scarify the margin. The full thickness of the marginal transitional skin must be carefully removed in small opposing rectangles 2 by 3 to 4 mm. on the upper and lower lids. Then the lid may be split in the area of the gray line to a depth of 1 mm. A double armed No. 000 or No. 0000 silk suture which has been passed through a small 2 by 5 or 6 mm. rectangular rubber plate is passed through the skin of the lower lid 2 to 3 mm. below the lashes and out through the center of the rectangle of the denuded area of lid margin up through the denuded area of the upper

lid and out through the skin 2 to 3 mm above the lashes. Two such intermarginal areas are joined, one on either side of the center which is left open as a peepsight for later use. The width of the adhesions may be varied according to the load they are to carry. The sutures should be tied accurately and not too firmly so that necrosis cutting through of sutures and loss of adhesion may not ensue.

The sutures may be cut at the end of four days and not be removed until the next day when they will have worked loose. The patient is instructed not to open the eyes and thus not endanger pulling the tender union apart during these first two dressings.

Subsequently after ten or twelve days the patient may attempt to open the eyes and to peek through the central slit. Gradually over a period of several months stretching occurs through use (Fig. 114).



BETHKE 34

Fig. 113—Technic of intermarginal lid adhesions. Incisions for dissection and for free dermic graft from the upper eyelid.

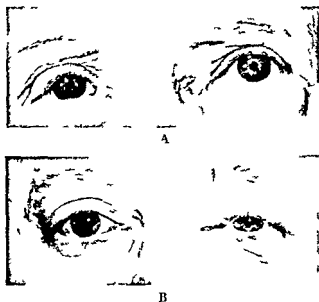
The union of the eyelids by these intermarginal adhesions is a great factor in shaping the newly reconstructed eyelids to the convexity and form of the eyeball.

THE DRESSINGS AND AFTER CARE—Gutta percha or a satisfactory synthetic substitute should be greased with petrolatum or other non irritating material and placed next to the skin surface. The area covered by the gutta percha should be only slightly larger than the area involved in the operation so that serum or blood oozing out may be absorbed by the gauze fluffs which are used to cover the gutta percha and to build up a filling for the cavity of the orbit. Adhesive strips are warmed and put on under tension diagonally across from brow to cheek to distribute accurately the pressure over the orbit. Then a roller bandage with protection pad for the ear is used to build up a

moderately firm dressing. The pressure should not be excessive particularly in the circular passes of the roller bandage but should be sufficient so that the dressing has a distinctly firm feeling, will stay in position without shifting, and will maintain the desired apposition of tissues until healing has taken place within four or five days.

The intermarginal sutures and stay sutures may then be removed carefully. All sutures may be removed within seven days since their usefulness passes within that period. Subsequent redressings until ten or twelve days after operation should be firm but not of the pressure type.

The gutta percha or substitute and the vaseline beneath the dressing may well be continued for this period. Subsequently for a varying



A

B

Fig. 114—Intermarginal lid adhesions. A Single adhesions on right upper lid. B Total adhesions left upper lid.

period of time the graft and the area operated upon may be anointed with a suitable grease and massaged until plasticity has been fully developed. The final effect of the operation is not evident for several months. Subsequent operations may well be deferred until full resolution of the changes in the tissues produced by the previous operation has been accomplished. Intermarginal lid adhesions should be left in place long enough to develop plasticity which occurs on movements of the eyes and until it is found that the lids follow the contour of the globe on all positions. They may then be severed and the lids separated.

Extirpation of the Lacrimal Sac in Traumatic Dacryocystitis—To quote from Wheeler⁴ In many cases removal of the tear sac is the most important step preliminary to plastic work for the repair of damaged

parts in its vicinity. It is unsafe for the surgeon to go ahead with plastic work until the purulent discharge from the sac is stopped and the only sure way to stop the secretion of the pus is thoroughly to enucleate the sac and sometimes a part or all of the nasal duct. In some cases with displaced or absent bony landmarks this is as difficult of accomplishment as it is important. [The reconstruction operation of dacryocystorhinostomy is not feasible in such cases. Author.]

The normal bony depression for the lacrimal sac is decidedly groove-like in shape and the proper anatomical term for this depression is lacrimal groove. This groove is formed in the superior maxillary and lacrimal bones. Anteriorly the lacrimal groove is limited by the anterior crest, a definite marking on the nasal process of the superior maxilla, low and rounded in its upper part and increasingly elevated and sharp in its lower part where the groove is deepest. Posteriorly the groove is limited by the posterior lacrimal crest of the lacrimal bone which also is increasingly prominent from above downward.

In operating for enucleation of the tear sac ordinarily there is one landmark of pre-eminent importance, namely the anterior crest of the lacrimal groove. Compared with this all others are insignificant for if the surgeon can dissect accurately to the marking he surely can locate the sac and if he has reasonable knowledge of the anatomy concerned and the necessary technique he surely can remove it in toto. However when the anterior crest is displaced, distorted or partially or entirely lost as is likely in cases of traumatic dacryocystitis difficulty may be in store for him.

The principle of locating some landmarks in traumatic cases and then following the lacrimal sac tissue, its fistulas and expansions should be used so that all of the diseased tissue may be removed and the suppurative process controlled before plastic surgery is begun. I have found this necessary in a boy run down by a truck and in several other patients who had been in automobile accidents. Those who are doing military surgery will find it worthwhile to read Wheeler's experiences as given in his case reports.⁹

To further quote from Wheeler: Reference to these cases of traumatic dacryocystitis which resulted from wounds in the lacrimal sac region, will serve to give an idea of the sort of condition with which ophthalmic surgeons may have to deal. They will also serve as an argument for thorough training in extirpation of the sac by the direct route. In such cases as these, though removal of the lacrimal sac relieves the patient from the discomfort and embarrassment occasioned by the purulent discharge, gets rid of a focus of infection which may have an ill effect on the patient's health and removes a genuine source of danger to the eye as some of these cases of cicatricial conditions interfere with the closure of the eyelids and lagophthalmus may allow loss of epithelium of the cornea. The two factors of loss of corneal epithelium and the presence of pus from a diseased sac offer ample

moderately firm dressing. The pressure should not be excessive particularly in the circular passes of the roller bandage but should be sufficient so that the dressing has a distinctly firm feeling, will stay in position without shifting, and will maintain the desired apposition of tissues until healing has taken place within four or five days.

The intermarginal sutures and stay sutures may then be removed carefully. All sutures may be removed within seven days since their usefulness passes within that period. Subsequent redressings until ten or twelve days after operation should be firm but not of the pressure type.

The gutta percha or substitute and the vaseline beneath the dressing may well be continued for this period. Subsequently for a varying

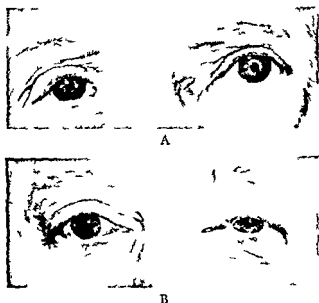


Fig. 114—Intermarginal lid adhesions. A. Single adhesion right upper lid. B. Two adhesions left upper lid.

period of time the graft and the area operated upon may be anointed with a suitable grease and massaged until plasticity has been fully developed. The final effect of the operation is not evident for several months. Subsequent operations may well be deferred until full resolution of the changes in the tissues produced by the previous operation has been accomplished. Intermarginal lid adhesions should be left in place long enough to develop plasticity which occurs on movements of the eyes and until it is found that the lids follow the contour of the globe on all positions. They may then be severed and the lids separated.

Extirpation of the Lacrimal Sac in Traumatic Dacryocystitis.—To quote from Wheeler⁴ In many cases removal of the tear sac is the most important step preliminary to plastic work for the repair of damaged

seen in many cases of war trauma as well as in injuries of civil life and the fact that failure to get proper healing with good results is the rule and not the exception is well known



Fig 115—Traumatic ptosis A Due to birth injury B Due to laceration C Due to contusion

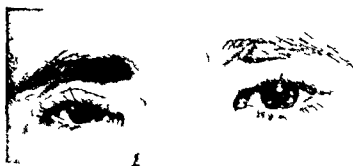


Fig 116—Cicatricial epicanthus

In this type of injury it is a difficult matter to get the apex of the lid flap to adhere accurately in position after first aid or subsequent reconstruction. Usually it heals in too low a position and fails to lie back in contact with the globe. For good correction in primary re-

construction the apex of the lid flap should be set fully up and back and in so that the lid will follow the convexity of the eye.

In a secondary repair all of the cicatricial tissue must be removed. The incisions should be made long enough to insure sufficient advancement of the flap so that the end will fall into position without any tension whatever after the sutures have been introduced. The external canthus is split outwards and the line of the laceration in the lower lid is extended then the pedicle flap so formed is undermined to its full extent. The conjunctiva is undermined and moved with the lower lid flap. To preserve the circulation of the flap this should widen and thicken toward the base.



Fig. 117—Ectropion. Upper Bilateral lower lids. Lower Unilateral lower lids.

SUTURING—Suturing should be started at the base of the movable flap and placed in such a way that the interspaces are greater in the stationary skin than in the movable lid flap, thus advancing the flap and relaxing it with each suture. This difference in spacing should be greatest near the base of the flap and should diminish toward the apex. In other words, traction should be greatest at the base and should diminish toward the apex of the lid flap, and at the end of the flap there should be none at all.

Anchorage—Proper anchorage of the angle of the lid flap back, upwards, upward and inward in a position of slight overcorrection is important. This can be accomplished by carrying the skin sutures through more deeply in the tissues on the nasal side than in the lid.

flap and by anchoring the apex back to the periosteum nasal to the internal canthal ligament thus carrying the lid flap as high as possible

The Correction of Cicatricial Ectropion of the Eyelids—The following description is Wheeler's^{6 7 10} with interpolations by the author. Cicatricial ectropion or eversion of the eyelids (Figs 117-118) is recognized as a difficult condition to handle satisfactorily. To get rid of the scar tissue responsible for the deformity, to cause the eyelid to lie accurately against the eyeball at the proper level, to get the effect of proper outline of the lid margins, to enable the patient completely and easily to close the lids without adding any appreciable deformity in the process—this is not easy. Because of the exposure of the eye and of the glaring deformity caused by the ectropion, the correction of this condition is decidedly important. Through the contraction of the scar tissue and the overflow of tears, the tendency is for the deformity to increase if it is not rectified by operation.

Restoration of the lid to its proper position, securing it in position and preparation of the bed into which the graft is to be laid are im-

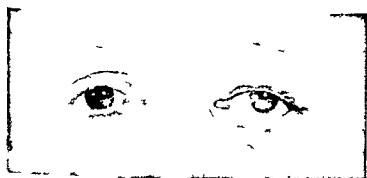


Fig 118—Cicatricial ectropion with keratitis e lagophthalmo

portant. Ordinarily a skin incision is made 3 or 4 mm from the lid margin, approximately parallel with it, following it even though distorted, and of about the same length as the palpebral fissure. The subcutaneous scar tissue should be carefully and thoroughly dissected out. As a rule there is more cicatricial tissue than there appears to be, and one cannot be too painstaking in getting this all out of the lid. Care should be taken not to injure cilia follicles, tarsus, or conjunctiva, and muscular tissue must not be sacrificed unnecessarily. After this dissection is completed, the lid should be relaxed sufficiently so that it may easily go back into position.

Then intermarginal lid adhesions are fashioned according to the technique previously described. If the eyeball remains, the upper and lower lids are sewed together and made to adhere to each other. This protects the eye and exposes the entire denuded area which will require covering by skin graft. If the eyeball has been enucleated, then the lids are sutured to the fundus of the socket so that the margins are in the level of the canthi.

TAKING THE TRUE SKIN GRAFT FROM THE UPPER EYELID—To quote from Wheeler: This is very simple as compared with the dissection of a dermic flap from the arm, thigh or elsewhere. Almost no allowance need be made for contraction. In fact, a graft exactly the dimensions of the raw surface to be covered will answer. This graft can be taken from either upper lid or if need be (if each upper lid will afford skin) two grafts may be taken to cover the raw surface. I have never found it necessary to take more than one for a single exposure of raw surface. From the upper lid of a young adult a piece of skin measuring from 20 to 25 mm wide and 50 mm long can be taken. From an elderly person greater width can usually be obtained without danger of lagophthalmos. In removing the graft, I do not use a grasping forceps of any kind for fear of bruising the graft. Outlining incisions are made through the dermis of the upper lid. A fusiform or semilunar shaped graft will almost always be needed and a graft of this design is convenient to take. A cataract knife is slid under the skin from the



Fig. 119—Ectropion upper eyelid. Ankyloblepharon.

lower incision to the upper. The knife is carried by careful sliding motions nearly to one end of the graft. Then it is turned about and carried to the other end, freeing it. The piece of skin is picked up with the fingers, not with the forceps, and set free.

If the graft is placed epithelial surface downward on a pad wet with warm (body temperature) normal salt solution, any fragments of subcutaneous tissue may be quickly snipped off with the scissors such as the curved Stevens Ophthalmic model.

Cicatricial Ectropion of the Upper Eyelid—If only one upper lid is deformed (Fig. 119), a piece of skin from the fellow lid makes an ideal graft. Obviously, skin should never be taken from a lower lid to use on an upper one, because this will cause an ectropion of the lower lid. The technic of the operation is the same for the upper lid as for the lower.

The stretched denuded area to receive the graft should be measured, or a pattern of the area can be cut if the operator wishes. All subcutaneous tissue should be cut away with flat scissors while the

graft lies on a pad of gauze wet with warm salt solution. After preparing the graft it is sewn in place with interrupted sutures. These should be carried through just at the margins of graft and surrounding skin.

Before sewing up the wound occasioned by removal of the graft there should be free undermining of the skin and sutures should be put in so that the margins of the skin flaps will be under complete relaxation with marginal sutures used to insure accurate apposition. There is no danger of lagophthalmos if the operation is done properly.

Severe Ectropion with no Suitable and Available Free Dermic Graft Material—To quote from Wheeler¹ "It is only for extreme ectropion from burns that I should use the epidermic graft. The severe type of ectropion usually involves all four eyelids and is associated with large areas of facial burn and possibly partial or complete loss of cilia and brows. The outer canthus may be pulled well down out of position and there may be cicatricial epicanthal folds. In such a case it may not be feasible to implant true skin grafts and it is convenient to resort to epidermis. Fortunately in these bad burn cases epidermis matches the scarred tissue of the face about as well as true skin from a distant part and it is possible to cover as large areas as necessary with epidermis."

After the preparatory dissection of the eyelids there is a large exposure for the reception of the epidermic graft. The upper and lower eyelids of both eyes if necessary are repaired at the same operation. The primary incisions should be parallel to the distorted lid margins. Cicatricial tissue should be so thoroughly and painstakingly removed that there will be no tendency of the lid to evert and scarcely more than normal resistance to traction at the lid margin. Usually in cases of bad deformity the dissection has to be carried well out beyond the external canthus. It is permissible for the denuded areas of the upper and lower lids to communicate at the temporal side of the palpebral fissures but it is a mistake for the surgeon to establish a communication at the nasal side as a fold will form during the healing process and make a cicatricial epicanthus or accentuate the epicanthal fold if it already exists.

Either two or three firm intermarginal adhesions between the upper and lower lids are made by dissecting off the epithelium at corresponding positions on the upper and lower lid margins and carrying mattress sutures through the little raw surfaces.

FREE EPIDERMIC GRAFT—After proper preparation of the bed of the denuded areas of the eyelids a single large piece of epidermis is placed over them overlapping the margins of the denuded areas all around. For this purpose a graft with an area of 9 to 12 square inches may be needed.

Wheeler used the Stille (Norwegian) graft knife to take the graft. He preferred the epidermis from the outer aspect of the thigh. The

part from which the epidermis is to be taken is shaved and cleansed with alcohol and ether. The skin and warmed knife may be smeared with a thin coating of sterile petroleum jelly to reduce the tendency of the skin to move with the knife. An assistant with a towel or gauze usually made tension on one end of the area while Wheeler used the edge of his left hand to hold the thigh skin taut and flatten out the surface. With the other he carefully shaved off the single large graft of epidermis ($2\frac{1}{2}$ to 3 inches by 3 to $3\frac{1}{2}$ inches) beautifully even and tissue paper thin, taking care not to perforate and not to go too deep.



Fig. 120—Entropion in children. Upper Spastic entropion. Lower Cicatricial and spastic entropion.

With the hand the skin surface can be so controlled that it can be depressed or elevated at different points as the need may be. The Padgett dermatome is used with great success for removing suitable epidermis grafts. The area from which the graft has been taken is covered by a petroleum jelly gauze dressing.

The bed for the graft having been prepared the epidermis is immediately placed in position without being put into a solution of any kind and without manipulation. It is adjusted and trimmed so that it will not overlap too much in any position.

Dressing—The graft should be covered with rubber tissue having

the slightest smear of sterile petrolatum. The firm pressure dressing and after treatment is in every way similar to those previously described.

Ankyloblepharon—This may be defined as an eversion of the eyelid with firm attachment to tissues less mobile than the lid such as that of the cheek or the brow or to fixed tissues such as the periosteum of the orbital margins. The dissection and freeing of the lids is most important. Incisions follow the lid margins no matter how deformed they may be. Normal tissues are preserved. Cicatricial tissues are removed completely. The lids are restored to their true position. Inter-marginal lid adhesions are made as previously described. Then the areas requiring skin grafting for covering are evident. Suitable grafts are selected and placed in position. The other care is similar to that previously described.

Entropion—*Cicatricial entropion* (Figs 120-121) requires somewhat similar treatment except that the vertical contraction and defect to



Fig. 121—Vertical shortening with entropion

be remedied are on the inner surface of the lid rather than on the outer. Cicatricial tissue must be removed carefully, then a suitable sliding or free graft of conjunctiva or buccal membrane is prepared and anchored in position by sutures which pierce the lid and are tied over the skin. Attention must be paid to deepening the cul de sac and remedying the defect of the vertical shortening of the lid.

Deformity of the lid margin with dystrichiasis associated with entropion must be overcome by various maneuvers. A successful one is that of splitting the lid along remnants of its gray line, then bringing the inner half forward of the outer and suturing it in this overcorrected position of approximately 2 mm so that the area of contact with the globe will be smooth and will thus protect the globe from the irritation of the lashes.

The excision of a narrow, elongated triangular piece of skin and wedge of tarsus may help particularly in entropion of the upper lid if a graft of conjunctiva or buccal membrane is inserted in the inner

side but it must be remembered that cicatricial entropion is usually accompanied by a deficiency of tissues with vertical shortening and that new tissue must be added for its correction.

Spastic entropion of the lower lid (Fig. 120) may be induced in any irritative condition of the eyes. If it is present and not due to scar tissue it may be relieved by properly placed Ziegler cautery punctures which go through the lid skin and orbicularis to the tarsus and induce vertical contraction. It is assumed also that the cause of irritation of the eye is discovered and overcome by treatment.

COLOBOMATA OR DEFECTS IN THE EYELIDS

Small Colobomata—These may be due to congenital malformations to trauma or to the surgical excision of neoplasms or cicatricial tissue (Fig. 122). For a very small notch the familiar V-Y procedure is useful. For small colobomata up to 3 or 4 mm the Halverson operation



Fig. 122—Coloboma (notch) upper eyelid

as described by Wheeler may be employed. The principle is simply that of joining by overlapping for greater strength and security adjacent portions of the eyelids. Cicatricial tissue is excised through the vertical defect in the lid including the margin, then the outer or skin half of one flap for approximately 2 to 3 mm and the inner half of the fellow piece to a equivalent length are scarified or cut away after which the two halves are overlapped and joined by through and through mattress sutures. Any puckering at the apex may be overcome by a suitable excision of a triangle of skin. This Halverson operation should not be used if there is not sufficient relaxation of lid tissues to permit proper coaptation without tension such as would exist if the coloboma were large.

Large Colobomata—Two procedures are applicable to large colobo-

mata (1) the use of a sliding pedicle graft from the temple if either or both upper and lower lids are involved or (2) the sliding of the inner half of the upper lid down to form the basis for a sliding graft of skin from the area below the eye. If neither of these is feasible then the problem is very difficult and one can only resort to a distant pedicle graft the end results of which are not satisfactory.

1 SLIDING PEDICLE GRAFT FROM THE TEMPLE—This procedure is for use in cases of large colobomata of either upper or lower or both eyelids. The following description of the technic is substantially that of Wheeler¹

Operations for correction of large colobomatous defects can be classed as important sight saving procedures because of the protection afforded to the eye by the reconstructed eyelid.

In congenital colobomata there is a characteristic little flap with a few cilia at the nasal limit of the coloboma. In traumatic or surgical colobomata the inner end of the lid serves the same purpose. This is split open to receive the denuded end of a large flap that is to be advanced to close the defect and cover the cornea. The margin of the coloboma is denuded of its epithelium all the way around and an incision is made in this cut margin to open it up slightly. Leading from the external canthus toward the temple an incision is made through the skin. Above this incision for the upper lid and below it for the lower lid another is made high enough to give proper width to the new upper lid and diverging slightly from the first as it goes backward. The flap should widen and thicken progressively as it is dissected toward its base. The incisions go nearly to the ear. At the posterior ends triangles of skin are removed above and below the flap so that closure of the defects so made will result in advancement of the base of the flap. These triangular excisions are convenient and slightly helpful but not important.

It is necessary that the lid flap be lined completely with epithelium and the best lining is obtained from the bulbar conjunctiva which is kept continuous with the existing lining of the temporal lid stump. After the skin flap between the long incisions has been dissected up except at the anterior end it is possible for the surgeon to slip the scissors under the flap and dissect the conjunctiva away from the globe on the temporal side of the cornea without breaking the continuity of the bulbar conjunctiva with the small area of palpebral conjunctiva. Thus a complete and uninterrupted conjunctiva lining is furnished for the reconstructed lid at the expense of the epithelial covering of the globe. This step is the one most to be emphasized in the entire surgical correction. The conjunctiva will gradually stretch and ultimately there will be no serious shortage of globe covering.

At the end of the flap a denuded tongue 2 or 3 mm wide is made by the removal of epithelium from the edge and from both anterior and posterior surfaces. This is to fit into the cleft that has been made

on the nasal edge of the coloboma. The tip of the flap should not be picked up with the forceps after it has been prepared but the advancement of the flap should be worked up from the base with the least possible manipulation of the anterior part of the flap. The advancement is accomplished by silk sutures which are carried through the fixed skin well ahead of points of entry into the movable flap. As much advancement of the posterior part of the flap as possible should be accomplished so the anterior part will not be on the stretch after advancement and will fit into its proper place without tension.

A secondary operation works out very well. This consists of shortening the palpebral fissure to average length or to match the fissure on the opposite side.

The necessary variations may be made to suit the case in which a large coloboma is produced by injury or by excision of cicatricial tissue or neoplasm. These schemes can be modified to suit conditions and one can say that the results are satisfying to both surgeon and patient. I have used this procedure in congenital cases in one involving both upper and lower lids as well as in cases of neoplasm and trauma.

2 THE RECONSTRUCTION OF THE LOWER EYELID FROM THE UPPER EYELID—The second method is that employed by Hughes¹ for relief of coloboma in the lower eyelids. It presupposes an intact upper eyelid. The inner half of the upper lid is freed and brought down to serve as a base for a sliding graft of skin freed and brought up from below the coloboma to the lower eyelid. The technic developed by Hughes requires a splitting of the lid margin along the so called "gray line" then dissecting well back along an easy plane of cleavage just anterior to the tarsus then anterior to the levator freeing the inner tissues with the conjunctiva so that they may be brought down and anchored at the lowermost portion of the coloboma. This principle may be used for a part or for the whole eyelid. The line of the upper lid margin and of the eyelashes is placed in a midway position on the level of the canthus. Then by undermining the skin below the sliding graft of skin and sufficient subcutaneous tissue is brought up from below to reach the edge of the anterior margin on the upper eyelid. Appropriate sutures are placed to hold the tissues in position without tension. Healing having been accomplished the lids are opened after months have elapsed in which plasticity has developed by cutting across just below the line of the lashes. There is naturally a tendency for the inner parts of both upper and the new lower eyelids to retract. I have suggested to Hughes recently that undermining and resuturing with slight overcorrection of this tendency to retract would be beneficial as it has been in a recent case of my own.

Modification of the Primary Dissection for the Reconstruction—To simplify the dissection and to save the shape and blood supply of the upper lid margin to avoid dystrichiasis it seems feasible to evert

the upper lid on an Erhart clamp to make the incision through the tarsus 2 to 3 mm from the upper lid margin and then to carry the dissection back on the easy plane of cleavage familiar to so many surgeons in operating for the relief of ptosis by resection of the tarsus levator and smooth muscle of the upper lid. The other features of the operation are as Hughes has described.

Symblepharon—Destruction of palpebral or bulbar conjunctiva or both may result in symblepharon, a union of lid and globe (Fig. 123). The correction is not always satisfactory because of the difficulty of removing all the cicatricial tissue and of furnishing sufficient conjunc-

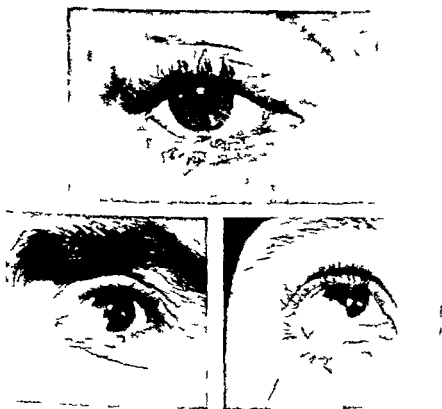


Fig. 123—Ectropion with symblepharon

tiva or satisfactory mucous membrane graft to cover the denuded area of eyelid and globe. In the first aid treatment of chemical and thermal burns it is not necessary to do other than put a little olive or mineral oil or petrolatum into the conjunctival sac in case of first degree injury except in the burns caused by irritating war chemicals and gases. In these in general oily medicaments are to be avoided. If the burn is of second or third degree and the globe is not destroyed symblepharon is inevitable and it is unwise to regularly separate the forming adhesions as advised in so many articles. The condition had better be treated conservatively waiting for resolution of the traumatized tissues before attempting a correction of the symblepharon.

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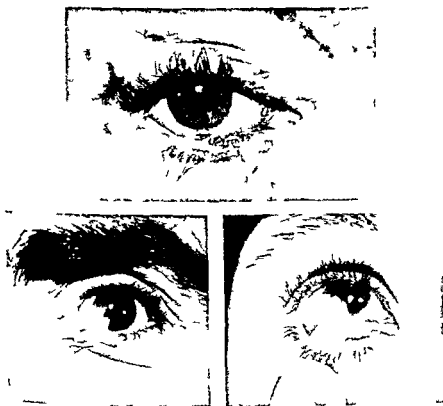


Fig. 123—Ectropion with symblepharon

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In the secondary repair by proper incisions through the conjunctiva the cicatricial tissue is reached and thoroughly removed. Care is exercised not to disturb Tenon's capsule or the extrinsic ocular muscles more than necessary and to use free or sliding grafts of Tenon's capsule to restore flexibility and motility as indicated. Proper covering and lining of the eyelids and globe to reform the conjunctival cul de sac are necessary. The neighboring conjunctiva may be slid over or a free conjunctival or buccal mucous membrane graft may be sutured into position. The whole work must be done thoroughly to be successful. Intermarginal lid sutures are used during the initial healing stage.

Reconstruction of the Obliterated Eye Socket—This subject has been masterfully treated by Wheeler.¹¹ The reader is referred to his description of the technic.

SUMMARY AND CONCLUSIONS

Under the term vertical shortening of the eyelids has been grouped a number of deformities arising from congenital malformation, trauma and surgical excision of tissue. Blepharoptosis, epicanthus, ectropion, entropion, arkyloblepharon, symblepharon, coloboma—all belong in this classification. The reconstruction of this group of conditions should be in the hands of those ophthalmic surgeons who have been trained in plastic surgery because of the importance of the preservation of the functional integrity of the eyeball.

The principles of plastic and reconstructive surgery of the eyelids as developed by Wheeler are stressed and added to from my own experience. The precise operative techniques, the methods of handling the tissues and the dressings are described in detail from practical experience. They are known to be satisfactory and they conform to the maxims. Never add a deformity in correcting a deformity and

Think first of the safety and function of the eye when planning plastic and reconstructive operations on the eyelids.

This presentation is made when there is urgent need for the proper correction of traumatic conditions of the eyelids. It is hoped that the employment of these tried techniques where indicated may save the vision and spirit of some of our wounded men.

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traction may shorten the palate somewhat. We believe that this operation if carefully performed leads to a minimum of scar contraction, but meeting these objections it is inadvisable to increase the nasal raw surface by excising the palate aponeurosis from the posterior border of the palate bone. Therefore we elevate the tissues from the palate bone on the nasal as well as on the oral side but leave the aponeurotic fibers of the palate muscles attached to the posterior

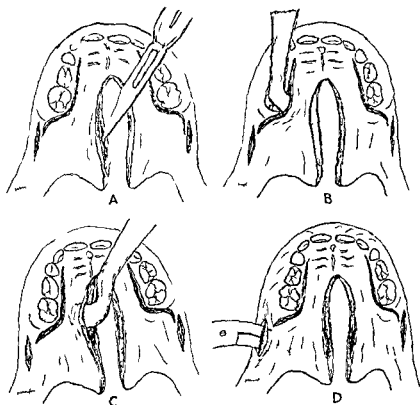


Fig. 124—Successive steps in preparation for closure of cleft palate. *A* Freshening of border by splitting the mucosa. *A* also shows location of lateral incisions and incisions for silver ribbon. *B* Elevation of the mucoperiosteum through the lateral incisions. *C* Elevation of the mucoperiosteum from the cleft border outward. *D* Insertion of pointed scissors externally to the pterygomandibular ligament and into the nasopharynx to form a path for silver ribbon.

border of the palate bone. The angular elevator is then inserted into the posterior end of the lateral incision first on one side then on the other. The flaps are carefully worked towards the median line until they can be united without tension at the junction of the hard and soft palates.

Incision for Silver Ribbon.—Using a No. 11 Bard Parker knife a incision is made in the pterygomaxillary fold external to the maxillary tuberosity and the palate muscles on the right side. Pointed curved

scissors are inserted into the incision (Fig 124 D) and are carried external to the pterygomandibular ligament in relation to the buccinator muscle. The scissors should be pressed inward to feel the resistance of the ligament. We know that the ribbon if inserted along this path will pass external to the pterygopharyngeal portion of the superior constrictor muscle. The point of the scissors is guided into the nasopharynx just posterior to the palate bone under the pillars of the

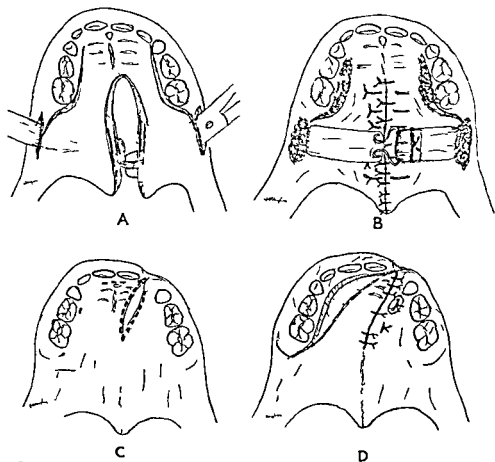


Fig 125—Completion of palate closure and incisions and suture for closure of anterior palate defect. A Insertion of silver ribbon. B Palate closed and sutured. Silver ribbon tightly drawn and tied. Iodoform packing inserted in the lateral incisions. C Dotted lines indicate incisions for repair of anterior palate defect. D Anterior defect closed and sutured.

fauces. They are opened to widen the incision and the same procedure is repeated on the opposite side.

Insertion of the Silver Ribbon—The tape guide attached to the ribbon is inserted into the incision on the right side and the end of the tape is picked up in the nasopharynx with a Kelly forceps. Another Kelly forceps is inserted into the incision on the left side (Fig 125 A) and is opened in the nasopharynx to receive the end of the tape which is then drawn through the incision until the end of the silver ribbon

appears in the sulcus. The two ends of the ribbon are clamped and dropped to the angles of the mouth.

Suturing the Soft Palate—Beginning at the junction of the hard and soft palates a straight needle about $\frac{1}{2}$ inch in length carrying a No. 000 dermal suture (which has been held in the eye of the needle by a single tie) is passed through the full thickness of the palate. The needle is held in the holder at an oblique angle and the point is picked up and drawn through. The needle is reinserted in the holder at an acute angle inserted in the nasal surface and drawn through to the oral surface. The use of a straight needle with equal bites gives a full thickness contact. Three or four of the sutures are inserted up to the base of the uvula. The two tips of the uvula are then grasped and united by a suture of No. 0000 dermal. Suture of the uvula is completed on the oral side (Fig. 125 B) then drawn forward and sutured on the nasal side. The nasal surface sutures should extend beyond the base of the uvula.

Suture of the Hard Palate—On end vertical mattress sutures of No. 000 dermal are used to close the mucoperiosteum of the hard palate. Interrupted sutures of No. 0000 dermal are placed between the mattress sutures to insure a water tight joint (Fig. 125 B).

Adjusting the Silver Ribbon—The tape end of the ribbon is passed through the wire loop at the other end of the ribbon. It is then drawn tight encircling the soft palate relieving tension on the suture line and completely immobilizing the soft palate. The buccal incisions will be seen to gape open as the sides of the palate are drawn toward the median line. The ribbon is folded on itself and thus locked. A small curved Martin needle carrying heavy silk is carried through a hole in the ribbon passed around twice and tied holding the ribbon securely (Fig. 125 B).

Insertion of Packing—Iodoform gauze dipped in sulfathiazole paste is inserted into the lateral incisions and also into the incisions through which the silver ribbon passes. The packing prevents nasal and oral secretions from sucking into the open incisions and infecting these areas (Fig. 125 B).

Closure of the Anterior Palate Cleft—When the hard palate cleft extends through the alveolar border or when the hard palate cleft extends to the premaxilla and is unusually wide and round (horse shoe shaped) complete closure in one operation may endanger the blood supply of the anterior ends of the flaps. It is then wiser to delay the anterior repair for several weeks.

THE ROTATED FLAP METHOD FOR ANTERIOR CLOSURE

This is by far the most satisfactory method for anterior palate repair. Beginning at the anterior end of the defect on the mesial side an incision through the mucoperiosteum is carried backward close to the teeth and around the tuberosity to the pterygomaxillary sulcus.

The mucoperiosteum is elevated from without inward to the border of the cleft. A thin shaving of tissue is removed from the border of the cleft on each side. The mucoperiosteum is freely elevated along the outer border of the cleft from within outward (Fig 125 C). The medial flap is raised from the anterior end, carried over the defect and held by a mattress suture tied down on a lead button. Several interrupted sutures of No. 000 dermal are inserted to produce a tight joint (Fig 125 D).

OPERATIONS FOR FURTHER IMPROVEMENT IN SPEECH

A cleft palate following repair may not be long enough to reach the posterior pharyngeal wall and thus will fail to prevent the passage of air into the nose in the articulation of consonants. The ultimate goal in cleft palate repair is normal speech and since successful anatomical closure of the cleft may not always attain this end, methods have been devised in an effort to narrow the opening between the oropharynx and the nasopharynx. The resourceful surgeon will study the conditions and make the utmost use of available material. In my experience about 45 per cent of the patients who have had successful primary repair of the palate will also have functional velopharyngeal closure at four to five years of age, especially if they have received efficient speech training.

When velopharyngeal closure is not present, the surgeon should then consider the advisability of further lengthening the palate. If the repaired cleft involves only the soft palate or if there is a slight extension into the hard palate, the Dorrance push back operation is the method of choice and is carried out in two stages.

PUSH BACK OPERATION

First Stage—An incision through the mucoperiosteum starts at the pterygomaxillary fossa on the left side, continues through the tuberosity following close to the lingual surfaces of the teeth and around the pterygomaxillary fossa on the opposite side. The flap within this incision is elevated from the underlying bone (Fig 126 A). The palatine arteries are severed as the flap is elevated from before backward to the attachment of the palate aponeurosis at the posterior border of the palate bone. A split thickness or Thiersch skin graft is sutured to the under surface of the flap—raw surface to raw surface. The flap is then returned to its original position and held in place by three or four sutures. Silver wires of 24 gauge are threaded between the teeth and across the palate for gauze support. Iodoform vaseline gauze is then packed under the wires to maintain even pressure on the flap.

Second Stage—The second stage is performed in three or four weeks after the first stage of the push back operation. The original incision is opened and the flap is then elevated. The palate aponeurosis is severed near the bone, leaving a rim of tissue attached (Fig 126 B).

The anterior border of the flap is later sutured to this rim. The lateral dissection is extended backward along the lower border of the internal pterygoid plate to provide complete relaxation and to permit a further pushing back of the palate. A mattress suture is passed through the strip of aponeurosis on each side of the midline (Fig 126 B) through the anterior margin of the retroposed flap and then tied

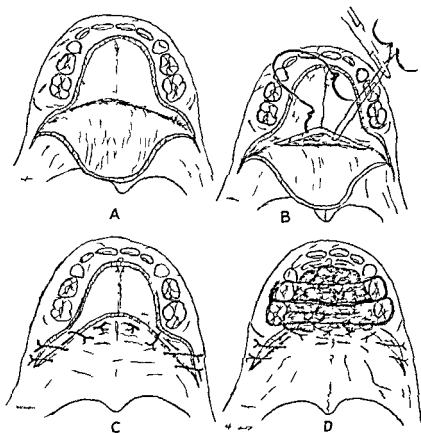


Fig 126—Succesive steps in the palatopharyngeal operation. A First stage: Elevation of the mucoperiosteum from the hard palate. B Second stage: Re-opening of the incision with elevation of mucoperiosteum. Incision through the aponeurosis. Mattress sutures passed through attached strip of aponeurosis. C Palate pushed back and sutured. D Silver thread placed between the teeth to retain gauze packing over a surface.

down. One or two oblique sutures are placed in the posterior part of the lateral incisions and tied down to hold the sides of the palate flap in a backward position (Fig 126 C). Silver wires are threaded between the teeth and across the palate as previously mentioned to support the petroleum jelly gauze that covers the raw surface (Fig 126 D). The maximum possible amount of retroposition of the palate should be obtained as forward constriction always occurs.

PALATE LENGTHENING FOR COMPLETE CLEFTS

The Dorrance push back operation is applicable to clefts through the soft palate only but the cleft extends into or through the hard palate in the majority of cases. This led to experiment with the principles of Ganzer and Dorrance and in 1934 the writer developed a procedure for lengthening the palate applicable to clefts through the hard palate and alveolus or of any lesser degree. The cleft is first completely closed by the methods previously described. If speech improvement is not satisfactory at four or five years of age the elongation is performed in two stages to allow for a reestablished blood supply before final retrotransposition.

THE AUTHOR'S PROCEDURE FOR LENGTHENING THE PALATE

First Stage—A straight needle held in a hemostat is used in puncturing the sides of the cleft to determine the bony defect. Starting just posterior to the teeth an incision is made down to the bone following the margin of the cleft to the posterior border of the hard palate. The knife is held obliquely to obtain as wide a mucoperiosteal flap as possible. The incision is repeated along the opposite border of the defect leaving a narrow bridge of tissue covering the original cleft (Fig 127 A). Lateral incisions are made on each side close to the teeth extending from the canine tooth around the maxillary tuberosity externally and across the pterygomaxillary sulcus (Fig 127 A). The mucoperiosteal flaps are elevated on each side along the extent of the lateral incisions severing the palatine arteries on each side (Fig 127 A). The flaps are then replaced and held by a suture in order to be certain that the blood supply is sufficient (Fig 127 B).

Second Stage—After a period of three or four weeks the patient is readmitted to the hospital and the incisions are reopened. The lateral and medial incisions are joined at the anterior ends. The two medial incisions are joined obliquely at the posterior ends (Fig 127 C). The flaps are elevated from before backward and the hamular processes are fractured on each side. The flaps are incised from the palate aponeurosis leaving a rim of attachment to the palate bone (Fig 127 C). The lateral dissection is extended along the lower border of the internal pterygoid plate to allow the palate to be further retroposed. A mattress suture is passed through the attached portion of the palate aponeurosis on each side then through the anterior ends of the retroposed flaps which are sutured together in the median line and to the posterior end of the tissue covering the original cleft. Oblique sutures are placed from within outward to hold the palate in backward position (Fig 127 D). Silver wire of 24 gauge is laced back and forth across the palate between the molar teeth as a support for the iodoform gauze which is placed over the raw surfaces as described for the *push back* operation.

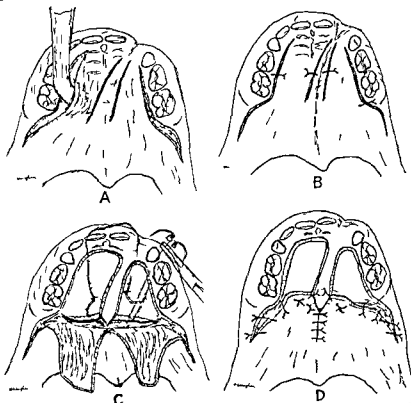


Fig. 127—Successive steps in lengthening the palate when completely cleft. A First stage. Lateral incisions and incisions which parallel the bony defect. Also elevation of mucoperiosteum through lateral incision. B Elevated mucoperiosteum replaced and held by sutures. C Second stage. Shows incisions opened and joined anteriorly and posteriorly in the midline. Mucoperiosteum elevated. Palate sponges incised. Mattress sutures inserted in attached strip of palate sponges. D Palate retroposed and sutured to midline section of tissue.

UNITING THE POSTERIOR PILLARS IN THE MEDIAN LINE

Passavant in 1862 suggested that the inner borders of the palatopharyngei be united together with closure of the soft palate in order to obtain a soft palate of greater length. This procedure is especially indicated for older children who present a history of two or more only partially successful operations. There is a loss of palate tissue and if the palatopharyngei have not been injured the posterior pillars are drawn forward the muscles have thickened widened and approached the median line at their palatal attachments.

It must be understood that the palatopharyngei cannot be used to obtain sufficient horizontal elongation of the soft palate to permit elevation against the pharyngeal wall as these muscles pass down the lateral wall of the pharynx somewhat posteriorly they can however be made to move closer to the posterior pharyngeal wall and by the assistance of the pharyngopalatine sphincter the muscles will approach

mate close enough to nearly close off the nasopharynx. In attempting midline union it is necessary to obtain complete immobilization of the palatopharyngei, and it is here that the silver ribbon is invaluable. Some of these cases are suitable for further lengthening by a push back procedure.

Operation—An incision starts at the point of union of the two muscles and passes obliquely backward 1 to 2 cm. to one half the width of the pillar. This incision is duplicated on the opposite side.

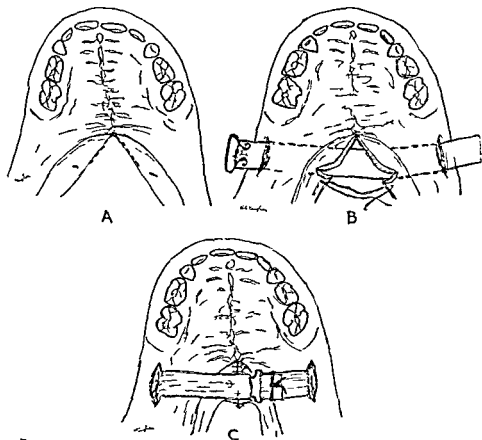


Fig 128—Successive steps in midline union of the palatopharyngeal muscles (posterior pillars) *A* Dotted lines show incisions in the posterior pillars *B* Incisions opened and a silk suture inserted in the posterior ends. Silver ribbon inserted through lateral incisions *C* Posterior pillars sutured and firmly immobilized with a silver ribbon.

(Fig 128 *A*) Another incision is made external to the palate muscles on each side; the silver ribbon is drawn through the incisions from right to left (Fig 128 *B*) and the ends are clamped. This procedure is fully described under closure of the soft palate. The ends of the pillar flaps are united with fine silk (Fig 128 *B*); the flaps are held back and the pillars are then sutured together from behind forward. The two ends of the silver ribbon are drawn tightly together and tied in the median line, thus completely immobilizing the pillars (Fig 128 *C*).

CONCLUSIONS

1 Surgical repair of a cleft palate before eighteen months offers no advantage from the standpoint of speech improvement. Efficient velopharyngeal closure is the important factor and the child stands the operation better when older.

2 From the anatomical standpoint the von Langenbeck operation with modifications is the best procedure for primary closure.

3 Palate operations should be carried out with a minimum of trauma and raw surface exposure.

4 The silver ribbon when correctly applied entirely prevents any separation of the suture line of the soft palate except the uvula.

5 Palate lengthening methods that have been developed in recent years represent a distinct advance in palate surgery.

6 An appreciable contraction of the elongated palate must be expected from the muscular action in addition to scar contraction.

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SKELETAL FIXATION IN THE TREATMENT OF FRACTURES OF THE MANDIBLE

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THE use of extra oral skeletal fixation appliances has had considerable publicity during the present war both in various professional journals and in the lay press. It has become a novelty that has captured the imagination of many in this age of mechanical contrivances. It has made a great appeal to the general surgeon who is inexperienced in using intra oral methods of fixation in fractured jaws. It has also made a great impression on the dental oral surgeon who aspires to the spectacular type of surgery.

INDICATIONS FOR EXTRA ORAL FIXATION

The extra oral fixation appliances have a definite place in the treatment of fractured jaws and should be used where they are indicated and not as a new routine technic in all cases as has been advocated by a few surgeons. These appliances are indicated in cases in which there is an absence of or inadequate intra oral anchorage for the usual type of splints wiring or arches. This would apply also to cases in which intra oral anchorage is present but the fracture is posterior to such anchorage. There are cases too where it would be of advantage to stabilize the fracture in good anatomical position and at the same time allow a degree of functional motion of the jaws or permit access to the mouth for treatment of the throat or oral tissues. Another indication is the fixation of the parts of the mandible when there has been a loss of the body of the bone and it is necessary to retain the parts in anatomical relationship when using a bone graft to supply the missing structure.

TYPES OF APPLIANCES IN USE

There has been a great deal of ingenuity displayed in designing these appliances to hold the parts in alignment. Basically there are two main principles employed to secure anchorage in the bone of the mandible. The first consists in the use of screws that penetrate the bone and retain their hold in the bone by the holding power of their threads. The coarser the thread the more holding power. Such screws may be used singly in a single fragment of bone or two screws may be used in a single fragment. The second principle consists in the use of pins of smaller diameter that may either be carried through two

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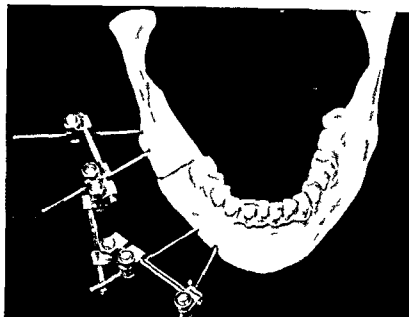


Fig 129—R g Anderson skeletal fixation appliance



Fig 130—Patient with multiple fractures of the mandible with marked displacement. Stabilized by Rieger-Anderson appliance

fragments of bone to transfix them as you might use a nail, or two pins may be drilled into a single bone fragment at a converging angle

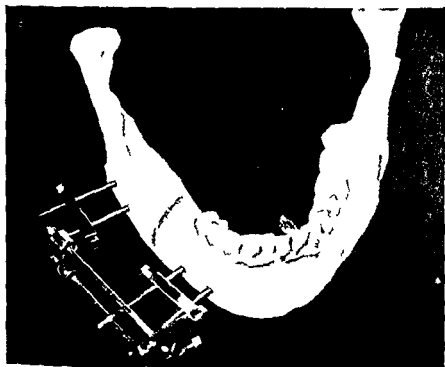


Fig. 131—Haynes Griffin skeletal fixation appliance



Fig. 132—Patient with Haynes Griffin appliance in use (Courtesy of Dr. Joe Griffin)

so that the triangular segment of bone between their converging axes resists the pull on their long axes and the resulting tendency to pull out of the bone

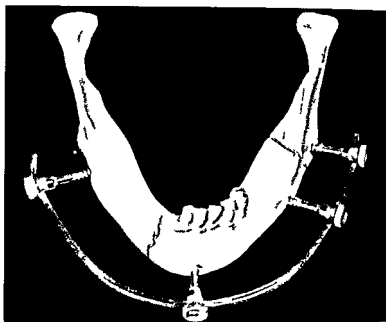


Fig. 133—Bogel external stabilizing plate head screws and knurled nut for tightening

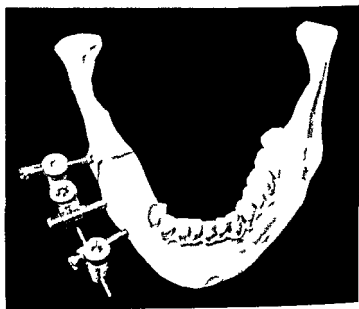


Fig. 134—Authenticating unsalvaged mandibles designed for surface gauging

The latter principle underlies the *Roger Anderson technic* originally used in fractures of the shaft of the long bones. In this technic the two converging pins are rigidly fastened together in an immovable unit (Figs 129-130). Similar units in each section of bone which is part of the fracture are attached to each other by a fixed rigid bar with adjustable couplings which can be tightened in place.

The *Stader splint*, originally designed for veterinary use follows much the same principle as the Roger Anderson splint except that it has a screw adjustment to approximate the sections.



Fig 135—Patient with triple fracture of mandible. Stabilized by author's appliance utilizing screws and surface gauge universal joints.

The *Haynes Griffin splint* (Figs 131-132) is a modification of the original Haynes skeletal splint used on long bones. This splint employs two small diameter screws placed parallel to each other at a fixed distance apart. These two parallel screws are held rigidly in a short bar with two holes and the screws are held in place by setscrews. The bars holding these screws are attached by universal ball and socket adjustable arms to two parallel stabilizing bars which connect the two units.

The *Bigelow fracture appliance* (Fig 133) uses screws with a coarse thread. The head of the screw has a deep slot into which a square alignment bar which is fixed and held in place by a knurled nut. Changes in alignment have to be accomplished by bending the external bar.

The literature has recently reported many types of screw attachments (Figs 14-137) as advocated by Berry, Bigelow, Waldron, Ivy, Converse, Brown and others. Some of these appliances employ straight

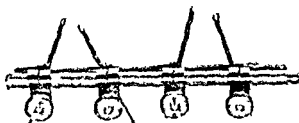


Fig. 136—Authors use of surface gauge universal joints and steel pins as suggested by Dr. Carl Waldron

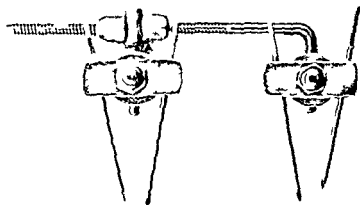


Fig. 137—Roger Anderson appliance modified by Brigadier General Fairbank and Colonel Stout of U. S. Army Dental Corps

rigid steel bars to connect the screws and others employ stiff wire contoured to the outside of the face or even bars of plastic material which can be heated and bent to the outlines of the face. These have been advocated by Ivy.

ANATOMICAL CONSIDERATIONS

In considering the use of skeletal fixation of the mandible it is important to remember that this bone so that we may apply the principle of advantage. Structurally the mandible

tical bone than the other bones of the face. This of course aids in pin fixation. The age of the patient is a great factor in the anatomical structure. In children the bone is small in size and the developing buds of the permanent teeth are distributed through much of the body



Fig 138—Cross section of mandible between the first molar and second bicuspid teeth. Note density of cortical bone at this point.

of the mandible, making it difficult to insert pins or screws without disturbing the developing teeth. On the other hand, the mandible in the aged, where teeth are lost, has little alveolar bone and the vertical diameter of the body of the jaw has greatly decreased in size.



Fig 139—Cross section of mandible at the third molar.

The mandibular canal occupies the central portion of the body of the mandible and thus limits the area used for fixation pins. A study of the cross section diameter of the mandible at various points (Figs 138, 139, 140) is important in determining the position of fixation pins.

to be inserted. The lower third of the cross section is made up of cortical bone in the main with very little cancellous bone structure in its central position. The width of the cross section of the body of the mandible varies from 7 to 18 mm in width and the ramus of the mandible varies from 3 to 15 mm in width. The very small or thin cross section of some portions of the ramus make it difficult to retain screws or pins in these portions for any length of time where there is very much muscular traction to resist.

In planning the points at which we intend to insert pins or screws in the bone we should use the available radiographs for detailed study



Fig. 140—Cross section of mandible just posterior to the angle. Note the small cancellous section at the lower border.

of the fracture lines, bone conformation and pathological conditions existing in the area. Where possible the fixation appliance should enter the body of the mandible in the lower third of the vertical diameter so as to avoid the mandibular canal or the apices of any teeth that may be in the area. In placing pins in the ramus of the mandible we should pick a point close to the angle of the jaw or close to the external oblique ridge if there is no third molar tooth in position. The central portion of the ramus is particularly thin and does not retain fixation appliances well. Furthermore the parotid gland lies over that portion and the inferior dental nerve lies inside the bone at this point.

TECHNIC OF INSERTING PINS OR SCREWS

The technic of placing the pins in the bone is important and has not been adequately described in many periodicals. It is important that the skin about the points where the pins or screws are to be placed should be adequately sterilized and a sterile technic carried out. Any intra oral manipulation of the bones to replace them in alignment should be done by an assistant who confines himself to the unsterile procedures.

Our object is to place the pin or screw in the portion of the bone that we wish to stabilize so that it has the strongest retention. The appliance should not be closer than 1 cm from the margin of the fracture line. The use of high speed power drills should be avoided because of the heat created and destructive action on bone cells. Various hand chucks or drills have been used to drill the pins into the bone or to drill holes in the bone to start screws into the mandible. Where there are small movable fragments in which pins are to be inserted, the ordinary hand pressure chucks will exert too much pressure and will tend to displace the fragment still further. In such a case the use of the small egg beater type of ratchet-gear drill is much to be preferred since it will drill the pin in place with a minimum of pressure.

The *depth* to which the pin or screw goes is important and should be predetermined by an accurate estimation of the width of the mandible at the point of insertion. We would like to carry the pin or screw through the entire cross section of the bone but do not wish to allow the pin to go through and traumatize the lingual tissues. I have followed the practice of marking the depth of insertion of the pin by the use of a piece of firm rubber placed on the shaft of the pin or screw by forcing it through the rubber. A $\frac{1}{4}$ inch circular piece cut from a rubber tubing suffices very well for this purpose. After the pin has punctured through the overlying soft tissue and has engaged the outer side of the bone the rubber depth gauge is then adjusted by sliding it along the shaft of the pin about the same distance back from the surface of the skin that has been determined to be the diameter of the cross section of the bone at this point. Then when the pin is drilled into the bone to the depth marked by the rubber gauge the proper depth of penetration of pin or screw is assured.

OTHER TECHNICAL POINTS

There are some cases in which it is difficult to determine accurately the posterior border of the ramus because of marked swelling or edema. In such cases I have used a sharp straight cutting needle as a probe to fix accurately the margin of the bone. With this left in place while affixing the stabilization pin or screw I can be more sure of my position. After the pins or screws are in position we can then

manipulate the displaced parts into an apparent anatomical relationship and by screwing the locking devices of the external stabilization bar we should rigidly fix the alignment of the bones

A postreduction radiograph should always be taken as a check for position. If the parts are not in as perfect alignment as we feel possible we can readjust the relationship of the fixation pins to the stabilization bar in the light of the information obtained by our postreduction radiograph.

In employing external skeletal fixation appliances we should try to use the external connecting bars as close to the skin as possible without pressing on the skin. This avoids long leverage on the pins which tends to loosen them. Long pins or screws that protrude from the face so far that they embarrass the patient when he is resting his head on a pillow should be avoided.

When the pins are first put into position we may apply a dressing of petrolatum gauze cut to straddle the pins. A dressing may not be necessary after the first few days. In males it is important to keep the hair carefully cut away about the pins and screws and to keep the skin clean with alcohol applied with cotton applicators. Serous crusts or scabs should not be permitted to form about the pins. Where such a tendency exists I have used a 5 per cent sulfathiazole ointment on the skin about the pins to soften the exudates.

If reasonable care has been used to sterilize the skin and to drill the pins into the bone under aseptic precautions and keep away from the fracture line infection about the pins will occur in only a trifling percentage of cases chiefly those in which the tissues about the pins are subjected to an unusual amount of muscular action.

RESUMPTION OF MASTICATORY FUNCTION

Some enthusiasts of the use of skeletal fixation contend that the patients can be allowed to carry on their normal masticatory function. My own feeling is that the mandible should be immobilized as much as possible for the first few weeks and after that the patient should be allowed restricted motion with a soft selected diet. The appliance can usually be removed after the fifth week unless there are distinct indications for its further use. Very little scar remains as a permanent disfigurement after the removal of the pins or screws. In many cases it can scarcely be detected at all.

SUMMARY AND CONCLUSIONS

The advantages of skeletal fixation in the treatment of fractures of the mandible may be summarized as follows:

- 1 It is applicable to some cases that cannot be managed by other methods.
- 2 It provides control of fracture parts.

3 It permits the opening of the mouth during treatment which results in (a) better choice of diet (b) the possibility of removing teeth if indicated and (c) safety in the use of general anesthesia

4 It is especially adapted to the treatment of military personnel

5 It results in an ability to hold the relationship of bones where bone is lost (a) for stabilization to prevent collapse and (b) for retention in bone grafting

6 It makes possible the better maintenance of mouth hygiene

The disadvantages of skeletal fixation in mandibular fractures follow

1 It is not desirable for ambulatory cases in civil practice

2 It is not desirable or necessary where intra oral anchorage will stabilize the parts

3 It increases the likelihood of infection

4 It may not aid in good occlusion of the teeth

5 It may leave scars or deformities in the skin

6 Pins or screws may become loosened or detached before ossification of the fracture takes place

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OSTEOMYELITIS OF THE JAWS

ADOLPH BERGER DDS

As in osteomyelitis elsewhere so also in osteomyelitis of the jaws intangible factors are at work along with the familiar and recognized ones in the etiology and pathogenesis of the condition. Specifically while osteomyelitis of the jaw frequently has its point of departure in an odontogenous infection yet in a group of apparently analogous cases of such infection some will develop osteomyelitis and some will not and there is no way of knowing in advance which will and which will not. Furthermore one cannot judge this with finality on the basis of whether the odontogenic infection had been treated conservatively or surgically (with or without curettage) and if surgically whether the anesthetic used was a local or a general one. Much the same idea holds true in regard to osteomyelitis of the jaw following upon external trauma. Indeed even in cases of compound comminuted fractures of the jaw following upon trauma osteomyelitis by no means consistently ensues. It hardly seems worth while here to speculate on the nature of the subordinate intangible general factors which apparently play their part in determining whether or not an osteomyelitis develops in connection with a given odontogenic infection or violent external trauma for instance.

ETIOLOGY AND PATHOGENESIS

In civilian life *odontogenous infection* is the most frequent cause of osteomyelitis of the jaw. In this connection what usually happens first is that the pulp of a tooth becomes necrotic and infected. Most commonly the infection occurs from organisms indigenous to the oral cavity which enter the pulp canal through a cavity in the crown along pathological paths by way of the root. On the other hand an otherwise intact tooth which has become devitalized by trauma or by chemical action may become infected by way of the blood stream. In either case a focus of infection becomes established at the root end of the tooth and may spread from there into the bone of the jaw in the vicinity of the tooth socket.

Osteomyelitis of the jaw developing *on the basis of metastasis* from a remote focus of infection is only rarely observed. Indeed, in my entire experience I have seen only a few cases of this type.

Occasionally also one may observe an osteomyelitis of the jaw

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which has developed by *direct extension* of an infection from an established focus in the soft tissues over the jaw

It may also happen that an osteomyelitis is set up through *direct introduction* of a source of infection. Thus in some cases in which there had been no previous evidence of infection an osteomyelitis develops after the deep injection of a local anesthetic with or without a local surgical intervention. I have observed two such cases in both of which infection developed in the sphenomaxillary fossa after deep injection behind the maxillary tuberosity given to anesthetize the posterior superior dental nerve for the removal of some upper molars. From this fossa the infection spread underneath the temporal muscle and then along the tissue planes to the submaxillary areas. In both of these cases the ascending ramus of the mandible on the side of the injection became necrotic. Under combat conditions direct introduction of an infection into a jaw bone may take place through contamination from the ground or from foreign bodies such as pieces of clothing or missiles.

CLINICAL COURSE

Clinically osteomyelitis of the jaw may be present in (1) an acute or fulminating (2) a subacute or (3) a chronic form.

Acute or Fulminating Stage—In a case of odontogenous osteomyelitis the earliest clinical symptoms arise in the offending tooth. The tooth becomes painful to touch or to percussion and may feel or actually be elongated. The infection spreads from the infected gangrenous pulp to the periodontal membrane and beyond an acute abscess about the root of the tooth being established in this way. On the other hand a nidus of chronic infection which has been present for some time around the root of a tooth may become activated and give rise to an acute abscess in this way.

Even after an abscess has developed it is still not certain whether or not a frank osteomyelitis will ensue. In any case there is now intense pain, which is deep seated throbbing and burrowing in nature. The removal of the offending tooth and establishment of drainage is usually followed by prompt relief of the pain and all other local and general symptoms. However if an osteomyelitis is developing intense pain continues until the pressure within the bone is at least partly relieved through the fact that at least some of the inflammatory exudate and pus has worked its way out from the bone and come to lie beneath the periosteum. The affected area is now tender to palpation and after there is pus under the periosteum the overlying soft tissues also show evidences of inflammation. These phenomena may develop in the course of a few hours or only in the course of several days. Intra-oral examination will now frequently show that the mucoperiosteum has been raised from the bone and is obviously dislodged. Fluctuation may be noted. All this can be best ascertained by comparison of the two sides of the jaw.

Later the periosteum may be perforated and the inflammatory exudate and pus pass into the soft tissues which now also present all signs of acute inflammation. If x ray films of the inflamed bone area have been taken it will be noted that the cancellous bone shows the first evidence of destruction. Subsequently the cortical bone is seen clearly to be affected and even a large area of it may be found to have undergone destruction. The rapidity and extensiveness of the bone destruction varies inversely with the compactness of the bone in the part affected. Specifically in the maxilla which consists largely of cancellous bone all the changes run a milder course than they do in the mandible.

If the infection is in the upper jaw the eyelids on the affected side and perhaps even on both sides become edematous and closed. In the lower jaw because of the special arrangement of the tissue planes and the direction of lymphatic drainage the pus tends to gravitate into the submaxillary areas. Osteomyelitis in the molar region usually leads to trismus. Other clinical findings include a picket fence temperature rising at times to 105° F., a high leukocyte count, chills, rapid pulse and general malaise. In a few cases vomiting is noted. In many respects osteomyelitis seems to run a more benign course in the jaws than in other bones. No doubt, patients with osteomyelitis of the jaw do sometimes suffer from bacteremia but in my personal experience it is only rarely that the condition even when severe has terminated in death.

The Subacute Stage—A case passing from the acute to the subacute stage shows of course a decided regression of the highly disturbing local and general symptoms. This is due to escape of the pus through an incision made for drainage or through sinuses formed spontaneously. However as yet it is not clear how extensive the bone destruction will ultimately be. Indeed in the subacute stage there are likely to be periodic acute exacerbations caused mainly by inadequate drainage. Damming back of the pus tends to favor an extension of the bone involvement and *pari passu* a return of the disturbing clinical manifestations and a prolongation of the disease. The wound now frequently has a fetid odor.

The Chronic Stage—In this stage the patient is comparatively comfortable the pain and fever and other disturbing local and general symptoms having completely or almost completely subsided. By this time one or more sequestra are well defined and probably even loosened and in process of being sloughed out. Drainage of pus persists however until all necrotic bone has been eliminated and may at times be quite copious. Complete elimination of the sequestra is usually followed by complete cessation of the drainage of pus. Continuance of the drainage of pus signifies that necrotic bone is still present which has not yet been sequestered and cannot be explained merely on the basis of the breaking down of granulation tissue.

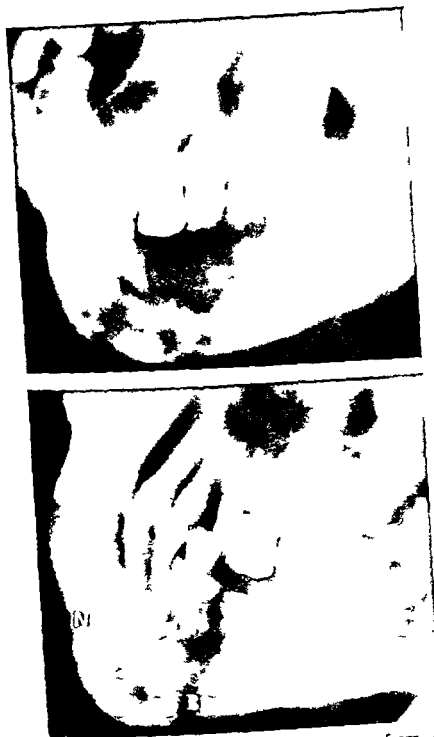


FIG. 141.—Osteomyelitis in a woman forty-eight years of age. An acutely abscessed molar was removed under nitrous oxide anesthesia and drainage was secured through an intra-oral incision. *Upper* Radiograph showing the condition about sixteen days later. The diffuse osteomyelitis is evident. *Lower* Three months later. Note the sequestrum, completely circumscribed, about which new bone NB has formed. There was no actual fracture in this case. The teeth which appear to be involved were retained and remained vital.



Fig 14.—The of m n th ty y rs of ge He rec ed a blow in th ante or part of h s ja Forty-eight h urs l ter an ac te infe tion de el op d h ch tended from the med n l n to the angle f the ja Th rado-graph (A) as t k n t this tum O t omyle t d lop d n h h the pure bone extend ng fr m the a el to the med an l n as compl tely lost. B The x nt of bone loss and som sequ tra fi e k s l ter are se n C The conditon nine months later ith ne bon N B fill ng the are

It is the delimited fragments of necrotic bone that constitute the sequestra. During the chronic stage these are being eroded by the inflammatory granulation tissue and even fragmented. The larger or smaller sequestra may be extruded either into the oral cavity or out through the skin. Hand in hand with the necrosis and sequestration goes the formation of periosteal new bone—that is of involucrum. The involucrum can be demonstrated in the x-ray picture. The amount of involucrum formation noted in some cases is truly remarkable (Fig 141). In several young children the writer has observed reconstruction of the entire ascending ramus of the mandible. The restored bony part though unlike the normal in either form or architectural detail was practically efficient. Nevertheless the subsequent growth of such a part was always stunted and ultimately the face was always more or less deformed. In adults there was enough reconstruction to replace sometimes even half of the horizontal ramus of a mandible in which there had been destruction of bone extending throughout its thickness (Fig 142).

Among the complications is *pathologic fracture* of the affected jaw bone. This may be anticipated but cannot always be prevented. The measures directed toward prevention are complete immobilization by means of splints or intermaxillary or interdental wiring. A sequestrum which lies in the line of a fracture or in a much weakened bone area should not necessarily be removed since it may help support the area of fracture or weakening while an involucrum is being deposited. Indeed under such circumstances the sequestrum almost seems to stimulate bone regeneration (Fig 143).

If a pathologic fracture has supervened bony union may fail to take place and the gap may be filled only by fibrous tissue. Surgical intervention will not be needed however if fibrous union firmly holds the bone ends together since with proper dental restoration fibrous union even in the presence of a pseudo arthrosis serves all practical purposes. However if the gap between the bone ends is considerable and the fibrous cicatrix fails to prevent flail like motion at the fracture sites under use of the jaws surgical intervention is indicated. By removing the connecting fibrous tissue freshening the fracture ends and raising the periosteum over a short distance to stimulate its activity the gap may at least be greatly reduced and even bony union may be obtained. The incision should be made from the outside and not from within the mouth and breaking through into the oral cavity should be carefully avoided. In cases in which the loss of bone is more extensive some form of bone grafting may have to be considered but the danger of rekindling the infection should be carefully borne in mind in this connection.

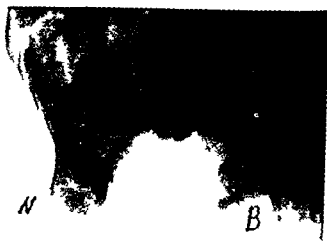


Fig 143—This is the case of a young man twenty-six years of age. The osteomyelitis developed after the removal of an infected molar. *Upper* The condition about seven months after the onset of the disease. Note the sequestrum at "S" the new bone formation "NB". *Lower* The same case after the sequestrum was removed. There is a pathological fracture which united subsequently however. The portion marked "NB" is new bone. All of the original bone spanning this area was lost.

TRAUMA AND OSTEOMYELITIS

Severe Violence—Severe external violence to the jaw region is of course often the cause of a fracture. The bone may be shattered and the fracture may even be compound and an osteomyelitis may develop. The bone fragments, deprived of their blood supply because of tearing of the vessels, undergo necrosis and such tissue is of course fertile soil for an infection (Fig. 144). In relation to the mandible fracture following a severe trauma may leave some large bone fragments still attached to the periosteum in which case rapid and satisfactory union may be brought about if the fracture fragments are brought into a favorable position. However, a mandibular fracture



Fig. 144—Comminuted fracture of the mandible in a man thirty six years of age. Note the sequestrum within the line of fracture and the new bone 'NB' being deposited subperiosteally.

fragment consisting mainly of an alveolar portion of the bone containing some teeth is very likely to undergo necrosis and become infected. On the other hand, an edentulous fracture fragment in a similar location is very likely not to be compound and tends to heal favorably and without the occurrence of secondary infection.

In the upper jaw osteomyelitis usually occurs when the bone has been comminuted and the fracture is compound. The compounding may take place toward the outside into the maxillary sinus or into the nasal cavity. Gaps in the bone communicating with the nasal cavity or the maxillary sinus do not heal by bony union. It is advisable under these conditions to prevent retraction of the overlying soft tissues by molding them and retaining them in as close apposition as

possible. In most instances, however, such openings have to be closed subsequently by a sliding flap operation.

The flap may be obtained from buccal tissue or from the palatal side of the opening or both. In some hands the buccal flap is more favorable and it offers several advantages. The buccal tissues are more elastic and pliable than are the palatal flaps. The stretch or motility of these flaps is limited, however, by the periosteum. To overcome this limitation, the periosteum should be incised, the incision being carried merely through the fibrous matting. Penetration into the cheek is to be avoided so that the deeper blood vessels may not be severed and the nutrition of the flap jeopardized in consequence. Often the available tissue is so sparse that the opening can be closed only with a prosthetic appliance. Tissue closure is preferable, however, wherever it can be achieved.

Trauma Caused by Curetting—It is frequently stated that curettage of a tooth socket after removal of an infected tooth is a traumatizing agent which may give rise to osteomyelitis. The common view is that the curettage activated an infection already present or that it introduced an infection into the freshly opened bone. On the basis of my own experience, I am convinced that curettage, if done judiciously, is rarely to be implicated as a factor in the causation of an osteomyelitis following the extraction of a tooth. If the curettage is done with proper precautions, the danger of introducing extraneous infections into the bone or soft tissue wounds is minimal.

GENERAL REMARKS ON TREATMENT

Incision and Drainage—It cannot be overemphasized that treatment of osteomyelitis of the jaws should always be symptomatic, expectant and conservative. The first concern should be to establish free drainage. Relief from intraosseous pressure can frequently be obtained through removal of the offending tooth. After the pus has accumulated underneath the periosteum, drainage should be secured by incision.

In the upper jaw, it is almost always possible to establish adequate drainage intra-orally. When the wound is compounded upon the face and the facial bones are comminuted, external drainage becomes necessary. In the lower jaw, and especially in the molar area, external drainage is frequently necessary. The incision is made in the sub-mandibular area or with counter drainage into the oral cavity.

The incisions, especially external ones, need not be so large as to invite undue scarring, but should be large enough to afford adequate drainage. It is important that the incision, after pus is reached, should be connected by blunt dissection with the bone whence the suppuration issues. This connection should be made with the least possible damage to the protective proliferations surrounding the pus collection. With free drainage, the local and general symptoms usually sub-

side The extent of the disease is not necessarily preventable.

Curettement—A curettement may be performed to remove or to eradicate the infection. It is not always possible to state it is impossible to determine the extent of the disease. The affected area may be the size of a pea or it may be the size of a fist. They should not be indiscriminately removed. The extent of the disease is the only factor in the choice of the method of treatment (see Fig 141).

Systemic Care—The general health of the patient is of great importance. Supportive measures such as increased caloric intake, rest, and food of high caloric value are necessary to the patient's general comfort. In a very small percentage of cases sepsis may develop and it is necessary to treat the patient accordingly.

Postoperative Care—In postoperative care we cannot but use the Orr treatment (permanent dressings) successfully used in osteomyelitis of extremities. Clean dressings and the maintenance of free drainage are important. The wound should be dressed every forty-eight hours during the acute stage to prevent retention and pocketing and less frequently during the chronic stage. In the choice of irrigating solution we need not depend upon the chemical composition or the bactericidal effect. Physiological irrigating with a fluid such as a highly diluted iodine solution or a saline solution will prove adequate if proper drainage is maintained. The use of solutions which depend upon the liberation of nascent oxygen such as peroxide of hydrogen should be avoided in all suppurative cavities.

The draining media should be of a substance which can be introduced into all parts of the pus pockets and suppurative tracts. As these cases often run a rather protracted course from a few weeks to several months the points of drainage show a strong tendency to close. Iodoform gauze 5 per cent has proved most satisfactory. Other substances such as fenestrated rubber tubing and rubber tissue have also been tried but are less satisfactory. The important thing is that the gauze should be used correctly. Specifically the drain should be carried to the bone and the pus pocket with its ramification should be loosely dressed and not packed with the gauze so that it may act as a wick and not as a plug. Clogging the outer orifice usually leads to retention and further complications. Unintelligent dressings frequently give rise to a need for secondary operations.

Roentgenographic Follow Up—Roentgenograms are of inestimable value not only in the diagnosis but also in the guidance of treatment of osteomyelitis. The radiograph may show no signs of the development of osteomyelitis for a week or even longer after the onset of the disease. Later a good roentgenogram can help one interpret the pathological changes that take place within the bone. It may show the

mottled appearance of the bone which is undergoing rarefaction and decalcification with its irregular bays of lost structure (Fig. 145). In diffuse osteomyelitis channeling of the affected portion of bone becomes evident. It is not to be assumed that all of the bone thus affected will be lost and it would be folly and often disastrous to base surgical procedures upon the assumption that all of the bone which appears to be undermined will have to be lost. The truly necrosed bone will eventually be isolated by the line of demarcation i.e. rarefaction, immediately about the sequestrum.



Fig. 145—Osteomyelitis of the mandible in a man forty six years of age. The radiograph was taken about four weeks after the onset of the disease. Note the mottled appearance of the entire half of the horizontal ramus and part of the ascending ramus. At this stage it is impossible to state what part of the bone will remain.

Sequestrectomy—The removal of the sequestrum should be deferred until complete detachment has taken place. This conservatism is especially indicated where a larger portion of the mandible is affected in which the complete substance of the bone is involved. For reasons stated above the sequestrum should be retained as long as possible. When the sequestrum is quite loose it can frequently be removed without further surgical measures. When the aperture in the bone or soft tissue is too small for passage of the sequestrum the opening is made large enough for its removal. This on occasion entails merely

a soft tissue incision. In some cases some of the surrounding bone which may be partly involucrum must be removed. Only where necrotic fragments are found mixed with detritus and nonviable granulation tissues should any curetting be done. The healthy granulations adhering to the healthy bone surfaces should be left intact for these layers are part of the protective mechanism and contain the elements of further bone regeneration. Dressing of the cavity should be continued however until it is fully or nearly obliterated.

Chemotherapeutic Aids—Sulfanilamide and its derivatives have not yet been used in a sufficient number of cases to justify a positive opinion as to their value in this connection. That it may be helpful in aiding the general condition there is no doubt. Penicillin has also not yet been sufficiently used especially in private practice upon jaw cases to permit the expression of more than impressions. For the time being sulfanilamide and its derivatives can be rationally used as a supporting measure and preferably under the guidance of a competent internist.

SUMMARY AND CONCLUSIONS

1 Many phases of the etiology, bacteriology and pathology of osteomyelitis of the jaws have not yet been sufficiently studied so that final expression of opinion is possible.

2 Odontogenous infections and trauma are the most frequent causes of this disease.

3 Arterial and venous thrombosis do not play the important role in the pathogenesis of the disease in the jaws which they are said to do in the long bones and especially in young subjects.

4 The pathologic processes may be arbitrarily divided into three episodes: (a) the acute, (b) the subacute and (c) the chronic.

5 Bone regeneration is much more prolific in the mandible than in the maxilla.

6 Bone defects in the maxilla communicating with the maxillary sinus or with the nasal cavity may well be closed with a sliding flap operation or with a prosthetic appliance.

7 Where bone regeneration is to be favored the sequestrum should be retained as long as possible since it acts as a scaffolding for the deposition of new bone.

8 Proper postoperative care is most important in the prevention of secondary untoward complications.

9 Roentgenograms are helpful in the diagnosis and the study of the pathological condition but can be misleading if treatment is based upon this evidence alone and the biologic potentials are not respected.

10 The effectiveness of the sulfanilamide drugs and penicillin will be decided only after a larger number of cases have been carefully studied and checked. The sporadic expressions of opinion published are mostly clinical impressions which can be evaluated only in the light of a more careful study.

CARTILAGE GRAFTING

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A SHORT time ago surgical opinion differed widely concerning the fate of various types of cartilage grafts after transplantation in human tissues. Clinical and experimental evidence now available provides information as to the fate of these grafts and this newer knowledge should enable the surgeon to choose rather definitely between autogenous, isogenous and preserved cadaver cartilage according to the requirements for any given case.

In this clinic I shall attempt to give definite indications for the selection of the proper type of cartilage graft and also describe the manner in which these grafts are used for the correction of deformities.

CARTILAGE AS A CONNECTIVE TISSUE

All connective tissues proper including cartilage are derived from mesenchyme which is a thin mixture of cells arising from the mesoderm. Hence the common cellular component of all connective tissue—the fibroblast—is a descendant of the primitive mesenchymal cell which has become specialized as a cartilage cell, a fat cell or the cellular component of some other form of connective tissue.

One should bear in mind that cartilage, bone, tendon, fascia, fat and the dermis of the skin are all connective tissues with the same type of cellular element—the fibroblast. These tissues differ in physical properties because of their different intercellular substance. Thus bone is rigid owing to a calcified substance between its cells; cartilage is firm but relatively elastic owing to a gelatinous intercellular material, and tendon is pliable and strong owing to the presence of tough bundles of fibers between its cells. Fat also is a connective tissue but it has a contrasting predominance of swollen cellular elements and a relatively small amount of intercellular material. Blood is a modified form of connective tissue and a transfusion represents the most commonly practiced grafting operation from one human individual to another.

It is interesting to note that all types of connective tissue may be successfully transplanted as free autografts and tend to retain their original structure through complete survival as with cartilage or through absorption and partial replacement as with bone and fat grafts.

PHYSIOLOGICAL AND CLINICAL CONSIDERATIONS

When transplanting living autogenous cartilage grafts an important consideration is the survival of the living element of cartilage. The

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cartilage cell The matrix is inanimate material produced by activity of the cartilage cells. If the cellular elements fail to survive transplantation the matrix will degenerate but if the cellular elements survive the matrix will remain. Obviously cartilage cells like skin cells may fail to survive when the graft is transplanted in debilitated patients with low plasma protein or with secondary anemia. The cartilage cells may also die when the graft is transplanted in tissues with poor circulation even though the general condition of the patient is satisfactory. Such grafts with dead cartilage cells may remain in place but over long periods of time the cartilage matrix will be invaded and replaced by fibrous tissue. This probably accounts for the occasional gradual disappearance of a few autogenous cartilage grafts.

The belief that thick autogenous cartilage grafts survive better than thin grafts is erroneous. The central portion of a thin cartilage graft survives better after transplantation than the central portion of a thick cartilage graft since the latter is further removed from its source of nourishment. A rule which applies to autogenous cartilage grafts is the smaller the graft the better its chances of complete survival after transplantation.

Three chief varieties of cartilage are distinguished. In one which is hyaline the matrix or intercellular substance is almost clear and free from obvious fibers. Actually this matrix contains dense collagenous fibrils held together with a binding mass of the same index of refraction which makes it appear homogeneous. When isogenous rib cartilage grafts are examined microscopically following transplantation one will often note absence of this cement substance which permits the dense collagenous fibrils to be seen. This is an early sign of degeneration and the prelude to later invasion and absorption of the cartilage graft. The hyaline cartilages commonly used for grafting purposes are rib cartilage, septal cartilage and alar or lateral cartilage.

The other two varieties of cartilage are termed fibrocartilage and are characterized by a matrix which is pervaded by obvious connective tissue fibers. When these are of a white variety the tissue is white fibrocartilage when they are yellow elastic fibers it is elastic fibrocartilage. The only type commonly used for grafting purposes is yellow elastic ear cartilage.

All types of cartilage are surrounded by a membrane the *perichondrium* which carries the blood supply for the avascular cartilage. Large masses such as rib cartilage may be invaded by an occasional blood vessel apparently because the mass of tissue is so great that adequate nourishment and elimination by simple diffusion is not possible. Fluids from vessels in the perichondrium and from the occasional penetrating vessels diffuse through the matrix to the cartilage cells and waste is eliminated by diffusion in the opposite direction. The exact mechanism of this diffusion is not known.

Growth takes place until adult life from the deep layer of con-

nective tissue cells of the perichondrium which form a matrix substance about themselves separate from the perichondrium and become cartilage cells. Growth also occurs by division of cartilage cells, followed by the production of matrix about each cell separating them one from another.

Autogenous cartilage grafts will survive following transplantation as living cartilage whether transplanted with or without their perichondrium. Adult grafts neither increase nor decrease in size the growth property being absent in adult cartilage. Dupertuis³ has demonstrated the actual growth of young auricular and costal cartilage grafts in rabbits which indicates the possible importance of using autogenous grafts in a growing child so that growth of the cartilage will keep pace with the general growth of the region grafted. I have noted definite growth in two segments of human ear cartilage which were buried after careful measurement in a child one year of age and removed two years later. This would indicate that Dupertuis' valuable observations on rabbit cartilage also apply to human cartilage. Obviously further investigative work with a larger number of cartilage grafts is necessary to determine the growth properties of young human cartilage grafts.

In summarizing it is seen that the matrix or intercellular substance of cartilage gives this structure its property of elastic rigidity and adapts it for its special function of support. The matrix, however, is produced by activity of the living cartilage cell and in transplanting autogenous cartilage the survival of this cell will determine the ultimate survival of the graft structure.

AUTOGENOUS CARTILAGE GRAFTS

Autogenous cartilage is always the material of choice for transplantation. It survives as living tissue, is not subject to invasion or absorption and it remains as part of the living organism until the individual in whom it is transplanted dies. This is true whether the cartilage is transplanted with or without its perichondrium. Experimental studies in humans have demonstrated that autogenous rib cartilage grafts retain their normal structure up until thirteen years following transplantation. Autogenous septal⁴, alar and auricular cartilage grafts also survive as living cartilage (see Fig. 146).

Factors in and Objections to the Use of Autogenous Rib Grafts for the Repair of Deep Depressions—Why then does the surgeon not always use autogenous rib cartilage for the repair of deep depressions? The objections to its use are enumerated and discussed as follows.

Dangers From the Chest Operation—Some surgeons feel that an operation to improve the appearance of a depressed nose does not justify the additional risk associated with the chest operation to obtain the patient's own rib cartilage. These men prefer to use inferior material in the form of foreign bodies such as ivory, vitalium and tantalum or preserved cadaver cartilage. Actually the removal of a pa-

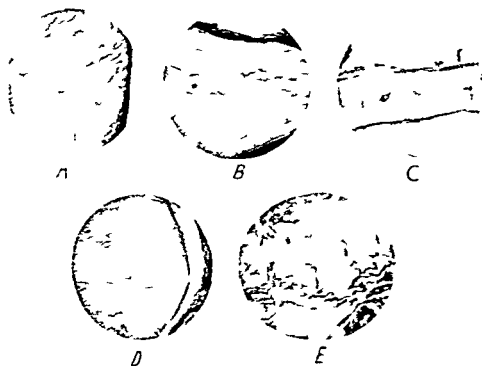


Fig 1-5—A Lower power magnification of an autogenous rib cartilage graft buried twelve years. Note complete absence of invasion or absorption. B Autogenous septal cartilage graft buried three years. Note absence of invasion and absorption. C Autogenous alar cartilage graft buried two and one half years. There is no evidence of invasion or absorption. D Autogenous ear cartilage graft buried three years. Note absence of invasion or absorption. Under high power magnification the cartilage cells in all of these autogenous grafts appear like living cells. E, Preserved cadaver rib cartilage graft buried eighteen months. Note invasion of cartilage by strands of connective tissue and loss of cartilage cell structure.

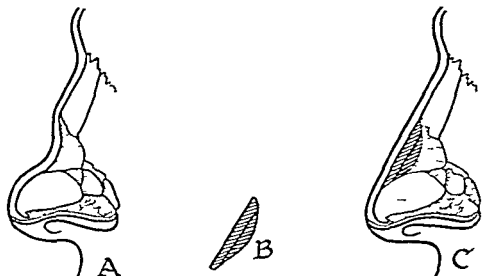


Fig 14—A Moderate saddle depression of lower nose. B Two segments of patient's septal cartilage suitably shaped are placed one on top of the other. C The two septal cartilage grafts are inserted beneath the nasal skin overlying the depression. Rather deep depressions of the nose can be satisfactorily repaired by septal cartilage grafts. When necessary, septal bone may be used to supplement the septal cartilage grafts.

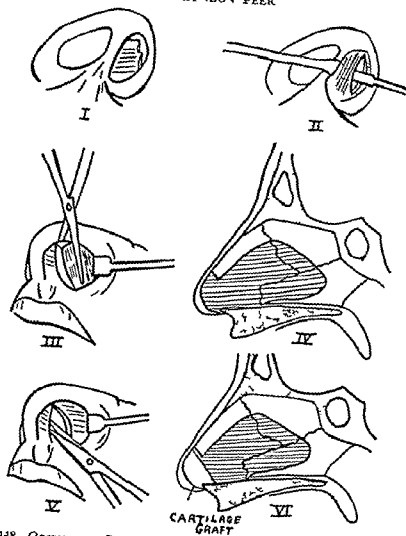


Fig 148—Operation to Repair Displacement of Lower Border of Septal Cartilage
 I Displacement of the lower border of the septal cartilage into the nostril. The displaced cartilage is pinned back and distorted and cannot be replaced in the columella.

II An incision is made on the right lower border and the mucous membrane is elevated on each side completely, exposing the cartilage.

III Excision of the distorted lower segment of septal cartilage.

IV Cross section of nose after removal of distorted lower segment of septal cartilage and the obstructive part of the septum further back.

V A pocket is made in the columella and a straight segment of septal cartilage is inserted into this pocket to support the tip of the nose.

VI Cross section showing septal cartilage graft in place. The mucous membrane is then replaced over both sides of the graft and a silk mattress suture is inserted through the columella to retract the graft in position.

When the displaced lower border of the septal cartilage is not too thickened or distorted, the surgeon may elect to expose the cartilage on both sides and remove some of the septal cartilage behind the displaced segment. This

nents chest cartilage is associated with very little additional risk in reasonably experienced hands. Infants and small children have a very mild postoperative convalescence and with adults the reaction is not severe if the chest is properly strapped.

Naturally the chest operation is contraindicated when the patient is not a good operative risk. In such cases the repair should be made with isogenous cartilage or preserved cadaver cartilage. If this modified type of procedure is associated with danger no operation should be performed.

Age of Patient—Children and young adults have a long life expectancy and they require longer lasting grafts than do elderly patients. Autogenous grafts are therefore indicated for young patients and isogenous or preserved cadaver cartilage for older patients.

Autogenous cartilage should be used in growing children because of the growth possibilities of young cartilage grafts. The chest operation is definitely not contraindicated in healthy infants one year or more of age since the postoperative reaction in infants is very mild.

Extent of Defects—Large skull defects especially in children may require a larger amount of filling material than the surgeon feels justified in removing from the chest wall. In such cases cadaver cartilage or isogenous cartilage may be used. By the diced cartilage method however a surprisingly large defect can be repaired from a moderate amount of the child's own cartilage. The bulk of the autogenous diced cartilage grafts can also be increased when necessary by the addition of diced isogenous or cadaver cartilage.

Objection by Patient—Occasionally a patient will refuse to allow the removal of his own chest cartilage. An explanation by the surgeon however will usually convince recalcitrant individuals.

When the patient is a war worker or in service it may be advisable to use cadaver cartilage since this modified procedure requires a shorter period of hospitalization and convalescence.

Distortion of Rib Cartilage Grafts—Living autogenous costal cartilage and living isogenous cartilage sometimes undergo a change in shape due to twisting or bending following transplantation. When the graft has been inserted in the nose the alteration in shape changes the line of the nose. This complication can be corrected however by a later trimming operation in which projecting portions of the graft are removed.

Alterations in the shape of the graft can be prevented to some ex-

renders the displaced segment mobile so that it can easily be sutured in proper position in the columellar pocket.

Both of these procedures utilize septal cartilage as a free graft. There are many possibilities for the use of septal cartilage grafts in nasal surgery and when the surgeon understands that autogenous septal cartilage grafts are reliable he will use them for a wide variety of conditions (Peer L. A. Arch Otolaryng 25:475 1937.)

test by proper removal and shaping of the cartilage before transplantation. The graft should be made to fit snugly in its bed with no dead spaces between the cartilage and the underlying tissues.

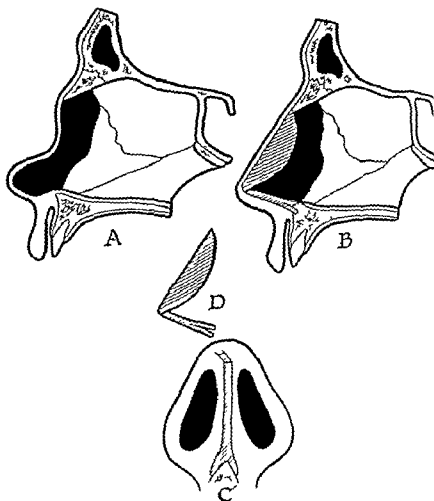


Fig. 149—Repair of Saddle Nose with Rib Cartilage Graft

- A Deep saddle depression of the nose
 B Lateral view showing large rib cartilage graft in place with a supporting buttress graft in the columella
 C Drawing showing how the rounded of cartilage graft is inserted in the columella, notched to fit over nasal spine. This prevents slipping of the graft
 D Relationship of the two cartilage grafts

Postoperative irregularities occurring when large segments of rib cartilage are inserted to fill extensive skull depressions can be prevented by using diced autogenous grafts. These small cubes can be patted into a rounded contour and they do not produce postoperative irregularities in the forehead.

In summarizing autogenous cartilage should be used whenever a small defect can be filled safely with septal alar or auricular cartilage. When the defect is sufficiently large to require rib cartilage the selection between autogenous isogenous and preserved cadaver cartilage must be determined by the surgeon's judgment in each individual case observing the rules which have been enumerated and discussed.

Use of Metal Supports—The metals vitallium and tantalum have a limited but important place as filling and supportive substances. These metals in time may or may not replace living isogenous cartilage grafts and preserved cadaver cartilage grafts. They will never replace autogenous cartilage grafts.

LIVING ISOGENOUS CARTILAGE GRAFTS

Living costal cartilage removed from one individual and transplanted beneath the tissues of another has been used rather extensively for *reconstruction of the auricle* in children. Gillies¹ more recently devised a method of auricle reconstruction in which ear cartilage removed from the mother's ear was transplanted in the child to form the structural framework for the auricle. I have been informed by men who have used this procedure that the late results are disappointing due to partial absorption of the isogenous ear cartilage transplanted from mother to child.

My own clinical observations of living isogenous rib cartilage transplanted from mother to child have indicated reduction in the size of the graft over long periods of time. One child who had mother's rib cartilage transplanted to form an auricle rather suddenly lost the complete cartilage framework two years after transplantation.

I examined sections of an isogenous rib cartilage graft buried three years and nine months and noted a complete absence of invasion or absorption and very normal appearing cartilage cells. Microscopic examination of other grafts buried a shorter period of time showed invasion and partial absorption of the matrix and degeneration of the cartilage cells.

My impression is that living isogenous cartilage is not a very reliable form of grafting material in certain cases while in others it appears to remain as living cartilage with normal appearing cartilage cells for long periods of time.

PRESERVED CADAVER CARTILAGE

Human cartilage preserved in alcohol was used rather extensively a generation ago to fill *depressions in the nose*. The procedure was discarded because of the belief that these grafts either suppurated or were rapidly replaced by fibrous tissue.

O'Conner in collaboration with Pierce revived the method utilizing fresh cadaver rib cartilage preserved in aqueous merthiolate solu-

tion and kept at refrigeration temperature until used. This preserved type of cadaver cartilage has a wide field of use and represents a valuable contribution to plastic surgery.

Experimental studies with septal and rib cartilage grafts preserved in alcohol and buried in human tissue have demonstrated that these grafts are slowly invaded and replaced by fibrous tissue over long periods of time. Their important field of application has been discussed earlier in this paper.

DICED CARTILAGE GRAFTS IN REPAIR OF DEPRESSIONS IN THE SKULL

In 1938 I reported on the operative repair of deep depressions in the frontal region of the skull in fifteen patients. The depressions were filled with segments of autogenous rib cartilage inserted one above the other. These patients presented normally rounded skull contours until about two months after the operation but from this time on irregularities developed which outlined the separate rib cartilage segments. The irregularities were most noticeable when an extensive depression had been repaired.

Secondary operations in which projecting portions of cartilage were removed served to improve the line of the forehead but did not completely correct the irregularities. Some immediate improvement was also obtained by introduction of sheets of dermal graft between the cartilage and the overlying skin of the scalp but the late results were disappointing. Depressions in the skull repaired by insertion of bone grafts likewise present postoperative irregularities similar to those seen after the introduction of segments of rib cartilage.

About six years ago it occurred to me that cartilage in small segments might lend itself to smoother molding. The cartilage could be cut into many fine cubes much as a cook dices carrots when preparing a salad. These fine cartilage cubes could then be introduced into an exposed depression in the skull and gently patted into a rounded contour and the skin of the scalp sutured over the rounded surface of the cartilage mass. I repaired a rather deep depression in the skull in this manner and was extremely pleased with the simplicity of the procedure and with the postoperative result.

Since then I have repaired depressions in the frontal region of the skull by this diced cartilage method in nine cases. The postoperative contours of the forehead in these cases have been far superior to those previously obtained with large segments of rib cartilage.

I experimented to learn what change or changes in the diced cartilage took place in situ. I stored the excess of diced rib cartilage beneath the skin of the chest of seven patients. After successful operation on the skull the stored excess cartilage was removed at intervals and sectioned. Microscopic examination showed that the spaces between the small cartilage cubes were occupied first by blood and later by ingrowing connective tissue accompanied by numerous blood ves-

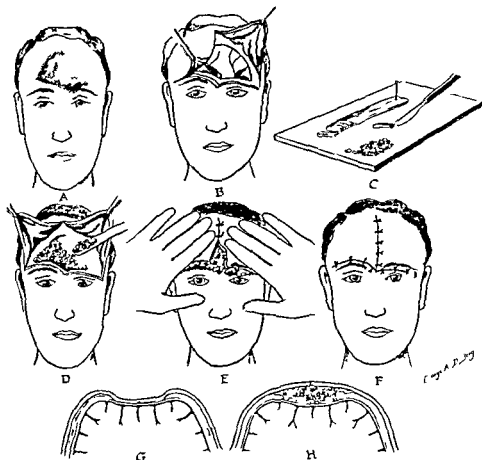


Fig 150—Repair of a Depression in the Skull with Diced Cartilage Grafts

- A* Deep depression in the frontal region of skull
B Exposure of a skull defect by an inverted T incision
C Method of dicing rib cartilage which has been removed from the right side of the patient's chest. This may be done by an assistant while the surgeon is exposing the depression in the skull. Fresh rib cartilage from a relative or preserved rib cartilage from a cadaver may be used instead of autogenous rib cartilage.

- D* Introduction of diced cartilage grafts into a depression in the skull.
E Method of gently patting the mass of diced cartilage squares into a rounded contour after the upper part of the midline incision has been sutured. Excess diced cartilage grafts are squeezed out through the lower portion of the incision.
F Skin of scalp completely sutured over the rounded surface of the diced cartilage grafts. On the left side the incision should extend through instead of below the brow.

- G* Diagrammatic cross section in the region of the skull defect before introduction of diced cartilage grafts.

- H* Diagrammatic cross section in the region of the skull defect after introduction of diced cartilage. (Peer L. A. Arch Otolaryng 38:156, 1943.)

Each small cube of cartilage rested against adjoining cartilage cubes at some points contracture of the cartilage mass being thus prevented. The filling in of the numerous small spaces between the individual cartilage grafts with connective tissue added to the bulk of



Fig 151—Repair of Depression Following Removal of Osteoma

A Osteoma arising from outer table of frontal bone

B Exposure of osteoma

C Osteoma removed with outer table of frontal sinus. A small section of frontal bone is removed above the sinus exposing the dura. The membrane lining the sinus is completely removed exposing the inner table of the frontal sinus.

D Entire cavity filled with finely diced cartilage grafts

E The upper part of the wound has been sutured and the excess of diced cartilage grafts is squeezed from the lower part of the wound with a curved metal ribbon.

F Wound sutured

G Cross section in region of frontal sinus showing osteoma arising from outer table of the sinus.

H Cross section in region of frontal sinus showing diced cartilage grafts filling defect.

the entire diced segments. For this reason the diced cartilage grafts actually filled a larger space than did the solid rib cartilages from which they were cut.

Autogenous diced rib cartilage grafts showed well nourished cells normal appearing matrix and complete absence of invasion or absorption. Preserved diced rib cartilage grafts showed definite invasion and partial absorption of the cartilage.

OTHER CLINICAL USES OF DICED CARTILAGE GRAFTS

Reconstruction of the Auricle—In 1942 I presented some cases of complete reconstruction of the auricle in which I had used diced autogenous cartilage grafts to form the framework for the recon-

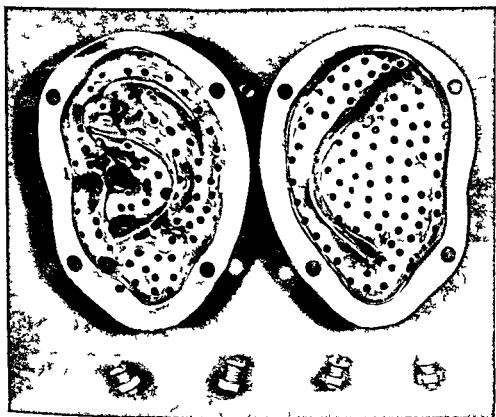


Fig 152—Vitallium ear mold used by the author which was made by the Austenol Company of New York. Another mold has been made recently with the depressions and indentations of the ear accentuated. The plaster model from which these molds were formed was sculptured by Dr Raymond Albray of Newark, New Jersey.

structed auricle. The advantage of this method was that it permitted the surgeon to form a cartilaginous plaque of any desired size from the child's own rib cartilage.

Following this meeting Dr Aufricht suggested the possibility of making an exact model of an ear from the patient's own cartilage by inserting finely diced cartilage grafts in a perforated vitallium mold, the vitallium mold containing the cartilage grafts being buried be-

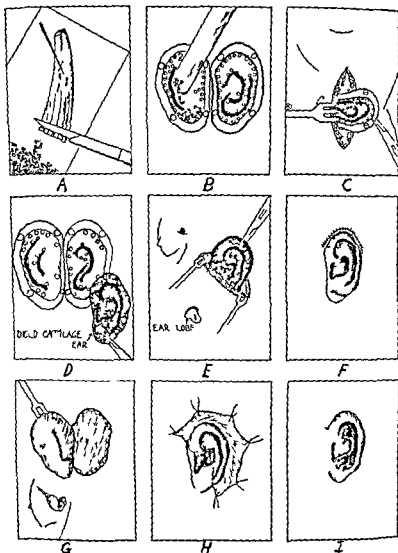


Fig. 153—Formation of Ear Framework from Diced Cartilage Grafts

A Method of dicing patient's rib cartilage into many fine cubes

B The diced cartilage grafts are introduced into each half of a perforated vitallium ear mold

C The two halves of the ear mold have been firmly fastened together with tallum screws pressing the separate cubes of cartilage into the shape of an ear. The mold contains the cartilage is inserted in a pocket beneath the patient's abdominal skin. During a period of three months connective tissue and blood vessels grow through the openings in the mold and fasten the separate cartilage cubes firmly together in the form of an ear. This can be accomplished perfectly.

D The vitallium ear mold has been removed from the abdominal pocket three months after transplantation. The two halves of the mold have been separated and the diced cartilage ear framework removed from the mold.

F The lobe portion of the cartilage ear is removed and the framework is inserted beneath the skin in the ear region.

neath the abdominal skin to permit connective tissue to grow through the openings in the mold and bind the diced cartilage grafts together.

Following this suggestion I had a plaster model of a normal auricle made and a perforated vitallium mold formed from this plaster model (Fig 152). I then removed cartilage segments from the chest of a young boy with congenital absence of the right auricle, diced this cartilage into many fine cubes and inserted them in each half of the vitallium mold (Fig 153). The two halves of the mold were then firmly screwed together and the mold inserted in a pocket beneath the child's abdominal skin.

Three months later the vitallium mold was removed from the abdominal pocket, and when the two halves were separated a perfect ear model formed from the patient's own cartilage was removed from the mold.

This cartilage framework was then successfully transplanted beneath the skin in the ear region and has been in place four months. I have not as yet inserted a skin graft behind the cartilage framework but the method appears to have definite advantages in that it reduces the operations to three separate procedures.

The various stages of the reconstruction of the auricle are shown in Figure 153.

I am presenting this case because it demonstrates that one can form a patient's cartilage into any desired shape by packing diced cartilage segments within a perforated vitallium mold and burying this mold beneath the patient's skin. When connective tissue and blood vessels have grown through the perforations in the mold and bound the diced cartilage segments together, the cartilage plaque in the form of the mold can be successfully transplanted elsewhere beneath the patient's skin.

Miscellaneous Uses—Diced cartilage grafts may also have a field of application in general surgery for the repair of *recurrent Hernia* for closure of the bony defect in *spina bifida* and for joint surfaces.

F The patient's distorted ear lobe which is usually present is sutured to the ear framework and a firm dressing applied to press the skin against the cartilage framework.

G About one month later the cartilage is separated above and behind from the underlying tissues.

H A split skin graft wrapped about a dental stent mold is inserted behind the new ear to cover the back of the diced cartilage framework and the raw scalp surface.

I Drawing represents the completed ear. Thus far I have been unable to make such a perfect appearing ear due to thickness of the covering skin which obliterates some of the sharp cartilage detail. It may be advisable to bury the diced cartilage framework beneath a hairless part of the neck skin near the clavicle. The back of the cartilage could then be covered by skin and the completed ear swung up into position by means of a neck flap. This would be advantageous in severe burns and other war injuries where the skin in the ear region had been destroyed.

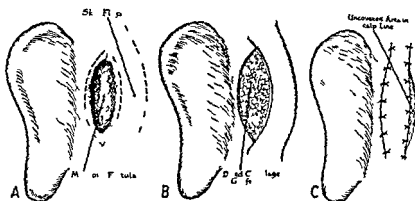


Fig 154—Repair of Mastoid Fistula with Diced Cartilage Grafts

A An elliptical incision is made about the fistula. The thin scar tissue within this section is then removed with exposure of the bony surface of the depression in the mastoid. A skin flap formed behind the fistula is indicated by dotted outline.

B The mastoid fistula has been filled with diced cartilage grafts to obliterate the depression and provide a base for the skin flap. Preserved cadaver cartilage is an adequate filling substance for a mastoid fistula.

C The skin flap is brought forward and sutured to cover the depressed area filled with diced cartilage grafts. The small uncovered area behind the flap heals by granulation and is not noticeable because it is located within the hair line. The skin flap may be outlined two weeks before it is brought forward to correct the defect in order to insure an adequate blood supply (Peer L. A. Arch Otolaryng 38 156 1943).



Fig 155—Method of repairing a depression on the malar bone with diced cartilage grafts. Depressions of the bony floor of the orbit and depressions in the mastoid may also be filled with diced cartilage grafts (Peer L. A. Arch Otolaryng 38 156 1943).

I have found the grafts useful as a filling substance for depressions in the mastoid resulting from simple mastoidectomies (Fig 154) and

for depressions of the malar bone resulting from an old injury or infection (Fig 155)

SUMMARY AND CONCLUSIONS

1 The important consideration when transplanting fresh autogenous cartilage is survival of the living element of cartilage the cartilage cell The matrix of the cartilage graft will remain unchanged if the cells remain viable If the cells die the matrix will ultimately be invaded and replaced by connective tissue

2 The central portion of a thin cartilage graft survives better after transplantation than the central portion of a thick cartilage graft since the latter is further removed from its source of nourishment A rule which applies to autogenous cartilage grafts is The smaller the graft the better its chances of complete survival after transplantation

3 Fresh autogenous cartilage grafts survive successful transplantation as living tissue whether transplanted with or without perichondrium Adult grafts neither increase nor decrease in size There is experimental evidence which indicates that young autogenous cartilage grafts continue to grow following transplantation

4 Living isogenous cartilage and preserved cadaver cartilage are inferior materials for grafting purposes In selected cases preserved cadaver cartilage has an important field of usefulness

5 A new technic of grafting by diced cartilage grafts is described

6 It is possible to form a patient's own cartilage into any desired shape by packing diced cartilage segments within a perforated vitallium mold and burying this mold beneath the patient's skin

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CERTAIN REPARATIVE PROBLEMS IN ORTHOPEDIC SURGERY

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REPARATIVE orthopedic surgery is a major problem in the Army general hospitals in this country. This is understandable if certain factors are taken into consideration. The present conflict has brought together a large number of young men who are in excellent health. They have been through many months of training in an effort to attain physical fitness. The treatment of shock by immediate first aid plasma and blood transfusions has contrived to save many of the injured who otherwise would have succumbed. Sulfonamide therapy has, unquestionably, served as a valuable adjunct to a well planned surgical program. Early debridement and the practice of never suturing the wound has minimized pyogenic and gas infection and thus contributed towards saving many wounded extremities from amputation.

High explosives, high velocity bullets and mechanized machinery have all contributed to extensive soft tissue and bone injury. Were it not for the fact that these injuries are sustained by strong and robust young men who fortunately receive very efficient first aid and most adequate early treatment, many would never survive and many of those who do survive would have lost the injured extremity. Although the injury most frequently encountered is the compound fracture, it is only one of the many conditions that must be dealt with to restore the injured soldier to duty or to a useful life in his community.

In the subsequent paragraphs we propose to discuss the following problems:

1. The septic compound fracture
2. Nonunion and loss of bone substance
3. Malunion
4. *Certain fractures of the scapula*
5. *Certain fractures at the wrist*
6. *Spondylolisthesis*

THE SEPTIC COMPOUND FRACTURE

The septic compound fracture apparently occurs with less frequency in relation to the total number of compound fractures than in the last war. The treatment at this hospital consists of improvement of the patient's general systemic condition, elimination of the infectious

process and necessary reparative surgery. Reparative surgery is not performed until such a time as the patient's general nutritional status will permit major surgery and infection has been relieved.

The patient with a septic compound fracture shows loss of weight and appetite, increased volume of interstitial fluid, decreased total circulating hemoglobin and decreased blood volume. These constant findings were described by Lyons¹ and our observation of his experimental and clinical studies at our hospital has been most convincing. The severe anemia and poor state of nutrition are best improved by the giving of ample *whole blood* and a *high caloric and protein diet*. Lyons has found that the patient with severe sepsis requires 2500 to 3000 calories each day and the diet must include a 20 to 25 per cent protein content to maintain the nitrogen balance. As the septic patient has lost weight, he must be given sufficient blood and plasma to restore the blood volume to the normal for his average weight. The nutritional status of the patient is often difficult to restore completely until his infection is well under control.

Infected compound fractures require ample drainage. The wound is irrigated and treated with sulfanilamide. A petroleum jelly pack is placed loosely in the wound to prevent its closure and to facilitate drainage. Care should be taken not to plug the wound with a pack, for such a procedure will prohibit drainage. A *plaster cast* is then applied to maintain the reduction as nearly as possible. We use a padded cast to protect the bony prominences. Very little sheet wadding is needed to protect the skin unless the patient is quite emaciated and the bony prominences are exaggerated. Windows should never be cut in the plaster. The change of plaster is infrequent, the time interval depending upon the amount of drainage and the severity of the infection.

It has been our experience that infected compound fractures of the femur should be treated by *traction* so applied as to permit knee motion. It is seldom possible to maintain reduction of a fractured femur by means of a plaster cast. Prolonged knee joint immobilization by the plaster spica causes stiffness which is often difficult to relieve.

Devitalized bone fragments and sequestra must be removed to effect a cure and this should be accomplished at the earliest possible time. The wound should also be examined for *foreign bodies*. It is frequently advisable to correct *overriding of fragments* and deformity by an operative procedure before wound healing is complete, thus preventing a union with retained shortening and deformity. When the patient has been properly prepared for this procedure by the maximum improvement of his nutritional status and the infection is under control, the operative reduction has not been followed by a flare up of the infection.

Sulfonamide and *penicillin* therapy, local and systemic, have served as invaluable adjuncts in the management of the septic compound

fractures. It should be remembered that the sulfonamides are likely to cause nausea with further loss of appetite and inhibit erythropoiesis in the bone marrow. Thus when they are used systemically there is a greater need for plasma and blood transfusions. Penicillin has been more effectual than the sulfonamides in our hands but because of its limited supply its use has been restricted to selected cases. Certainly the use of penicillin has permitted a performance of necessary surgery with greater safety and at a much earlier date.

NONUNION AND LOSS OF BONE SUBSTANCE

The common causes of nonunion as seen in war surgery are compound fractures which may have lost bone substance at the fracture site, muscle interposition, distraction which is frequently observed when pins have been used, and improper immobilization.

The healed compound fracture with nonunion often presents an adherent scar over the fracture site. It has been our practice in the severe cases to apply a full thickness skin graft before performing a bone grafting operation. This is done to prevent postoperative breakdown of the scar and if there should be a flare up of latent infection it is of less consequence to the skin than it would be to the bone graft. The preparation of the skin preparatory to bone grafting is most important. The operation should not be performed in the presence of impaired circulation. The time interval between complete wound healing of the compound fracture and the operation calls for special consideration in each individual case. Many factors must be taken into consideration particularly the type and duration of the infection, the circulation of the extremity and the general condition of the patient. This time interval may be shortened by appropriate sulfonamide or penicillin therapy. It is felt that penicillin is particularly beneficial when given preoperatively and postoperatively in connection with any reconstructive procedure on the healed compound fracture.

Nonunion is usually repaired by autogenous transplantation of bone. Large defects of bone may be treated by the use of metallic replacements instead of bone in selected cases but the indications for such a procedure are rarely encountered. We have used a metallic replacement in only one instance. Each case is given individual consideration in an effort to plan the least complicated procedure that will most likely cure the nonunion or defect and reasonably assure maximum function. It is our practice to use ample bone which is usually taken from the tibia. The majority of nonunions may be cured by inlay or onlay graft. The fibula was transplanted into the arm to replace a large ulnar defect in one case but the result to date makes us believe that the use of the fibula as a graft should be confined to the repair of large tibial defects of the same extremity. Dual grafts have been used to replace a large tibial defect with excellent results in the one case so treated in our hospital.



Fig 156 (Case I)—Nonunion of both tibias *A* Left tibia—preoperative *B* Left tibia—sixteen weeks postoperative *C* Right tibia—preoperative *D* Right tibia—thirteen weeks postoperative Note drill holes to promote revascularization

The onlay graft has been found ideal for treatment of nonunion of the shaft of the humerus and femur. When treating nonunion of

the femur we always apply a massive onlay graft and a bone plate. The use of the plate permits postoperative fixation in traction rather than a plaster cast thus affording early knee motion.

In most of our bone grafting operations we routinely employ multiple chip grafts to pack about and within the fracture site. It is felt that the free use of multiple chip grafts adds materially to the development of union. The bone ends must be properly denuded of all scar tissue and sclerotic bone before application of the graft. The periosteum and adjacent soft tissues are disturbed as little as possible.

CASE I (Fig. 156)—A twenty year-old soldier was admitted to the hospital nine months after having sustained compound fractures of both tibiae. The wounds were healed ten months after injury. The patient presented definite clinical and x-ray evidence of nonunion of both tibiae. The skin was necrotic and in condition.

Treatment of one leg consisted in the application of an onlay graft from the same tibia. The graft was fixed with tallum screws. Multiple chip grafts were also used. The second leg was operated on in the same manner three weeks later. Complete recovery was uneventful and union was obtained.

This case illustrates our usual method for treating nonunion of the tibia. In selected cases the graft is removed from the well tibia. This operation has been performed sixteen times in our hospital with no



Fig. 157 (Case II)—Nonunion of radius following gunshot wound. A Preoperative. B Nineteen weeks postoperative. Union present.

failures to date. One operation has been done so recently that the end result is unknown but union is anticipated.

CASE II (Fig 157)—This soldier developed nonunion in the radius following a gun shot wound. The forearm was draining at the time of his admittance to our hospital. Five months after the injury and two months after healing of the wound, bone grafting was performed. The bone ends were treated in the usual method. The graft was removed from the tibia. An onlay type of graft was used except that the radius was recessed sufficiently to prevent an undue prominence of the graft. Recession is unnecessary in the humerus and femur because the shafts of these bones are well padded by muscle. The cortical graft and recipient site were trimmed so as to permit medullary contact. The graft was fixed with four vitallium screws. Multiple chips were used. Convalescence was uneventful. The patient developed solid union with no evidence of recurrent infection.

This case illustrates our method of treating nonunion of the bones of the forearm. In an occasional case, particularly when both bones are involved, either or both bones are plated as well as grafted. We have to date performed ten such or similar operations for nonunion.



Fig 158 (Case III)—Nonunion of femur after simple fracture. *A* Preoperative. *B* Eight weeks postoperative.

on the shaft of the radius or ulna. There is one known failure to date. Operation has been done too recently in one case to permit an evaluation of the end result but union is anticipated.

CASE III (Fig. 158)—A twenty-one year old soldier presented nonunion of the femur six months after having sustained a simple fracture of the femur. A bone graft of the onlay type was used. The cortex of the femur was denuded sufficiently to expose the medulla so that the medulla of the graft was in contact with the medulla of the recipient. A vitallium plate was used to provide adequate immobilization and also to permit early knee motion. Convalescence was normal and bony union resulted.

Nonunion of the femur is treated by the application of a massive onlay graft and additionally of a vitallium plate. Supplementary multiple chip grafts are used. We have employed this operation in five cases with excellent results. In one case of nonunion of the femur a sliding inlay graft was used but a plate was not applied. Union was delayed but finally occurred after six months. This patient had not received proper consideration of his nutritional status and after four and a half months of failure to show clinical or x-ray evidence of union blood volume determination showed a marked reduction which was relieved by repeated blood transfusions.



Fig. 159 (Case IV)—Insufficient callus formation after comminuted fracture of femur. *A* Preoperative six months after injury. *B* Postoperative.

CASE IV (Fig 159) —This soldier was admitted with a healed gunshot wound of the right thigh. The shrapnel had caused a severely comminuted fracture of the femur. Insufficient callus developed after a period of eight months to permit weight bearing. A tibial onlay graft operation plus the use of multiple bone chips was performed. It was noted at operation that extensive muscle interposition was present. The strength and size of the femur at the site of limited union was materially increased by the operation.

This patient did not present nonunion at the time of operation. Bone grafting was performed to provide sufficient bony substance for weight bearing.



Fig 160 (Case V) —A Extensive loss of proximal extremity of radius B Following removal of Steinmann pin C Postoperative vitalium replacement D Nine months postoperative (Continued on following page)



Fig 160 (Case V) (Cont med) —E Motion in flexion and extension F Motion in supination G Motion in pronation

CASE V (Fig 160) — A soldier sustained a compound fracture of the proximal half of the radius from the explosion of a 0-mm. shell. Nearly two months were required for complete wound healing. There was no infection. The extensor and supinator muscles showed loss of function but there were no sensory disturbances.

A long tibial graft or replacement by fibula was considered but it was felt that better function of the elbow and forearm could be obtained by the use of a vital hum replacement. Four months after the date of injury the replacement was applied. Six months after this operation the flexor carpi ulnaris muscle was transplanted in order to obtain motion in supination.

This is the only instance in which we have employed vitallium plates for this particular fracture. Ten months after the replacement the patient presents good function of the arm except that the wrist and finger extensors are still weak. The flexor carpi radialis may at a later date be transplanted into the extensor tendons in event excessive weakness in extensor power persists.

MALUNION

Malunion has not been frequently encountered. It arises usually when the patient has suffered multiple and very severe injuries and the primary problem has been the saving of his life. Efficient early



Fig 161 (Case VI) — Severe coxa vara deformity and 90 degrees of external rotation of distal fragment following compound, comminuted intertrochanteric fracture of femur. A Preoperative B Following intertrochanteric osteotomy.

Presented before the American Academy of Orthopedic Surgeons, Instructional Section on "Bridging Large Bone Defects," January 2 - 6, 1944.

treatment of the fracture has been impossible. An occasional case is seen which may be attributed to the discontinuance of support before the fracture becomes firmly united.

CASE VI (Fig. 161) —A twenty year old soldier was admitted four months after having suffered a gunshot wound to the right thigh with resultant compound comminuted intertrochanteric fracture of the femur. The wound had been healed for longer than two months. The patient had a severe *coxa vara* deformity and 90 degrees of external rotation of the distal femur. An intertrochanteric osteotomy was performed with correction of the external rotation and the *coxa vara* deformity.

FRACTURES AT THE WRIST

Injuries to the wrist are frequently encountered. Quite often the injury has been so extensive that spontaneous fusion occurs. Care should be exercised to insure fusion in the proper position for arthyllos. Upon two occasions a fracture of the distal radius (Colles) had healed with so much deformity that osteotomy was performed for relief of pain and improvement of function. The results in both of these cases were excellent.

Nonunion of the carpal scaphoid occurring in line of duty and with sufficient retained pain and disability to prevent duty has been seen upon several occasions. Our treatment of choice in this type of



Fig. 162 (Case VII) —Fracture of scaphoid nine months after injury with marked displacement and nonunion and a dorsal dislocation of all the carpal bones on the radius except the trapezium. A Preoperative B Postoperative C Motion in flexion and extension D Motion in abduction and adduction

case has been an open operation to drill the fragments and the application of a bone peg which is removed from the adjacent radius. In the few selected cases in which this operation has been performed the result has been satisfactory.

CASE VII (Fig 167) —A thirty year old soldier was admitted nine months after having sustained a severe wrist injury. The wrist was painful and motion was limited. X rays showed a fracture of the scaphoid with marked displacement of the fragments and nonunion and a dorsal dislocation of all the carpals on the radius except the semilunar. At operation the entire proximal row of carpals was removed. Four months after operation he presents good function and no pain except after strenuous use of the hand. Extension of the wrist is still moderately limited but the other motions are nearly normal.

FRACTURES OF THE SCAPULA

Fractures both simple and compound in and around the shoulder joint are commonly seen. In the gunshot injuries the problem is chiefly

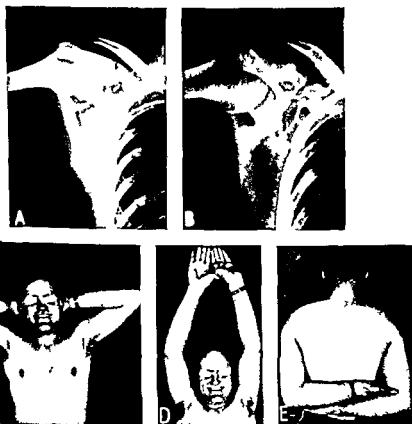


Fig 163 (Case VIII) —A Fracture of right scapula on admission to this hospital ten days after injury. B Four months after injury. C D E Range of motion four months after injury.

one of clearing up the infection which is usually present. Fractures of the scapula have been seen occasionally in patients with multiple in

juries and have healed without residual disability with a minimum of treatment to the fractured scapula

CASE VIII (Fig. 163)—A twenty eight year old soldier was admitted ten days after a severe shoulder injury. X rays showed a fracture through the base of the glenoid cavity with marked comminution of the body of the scapula. The glenoid cavity was markedly displaced medially. Strong traction was applied and was continued for six weeks with no relief of the displacement. It was quite evident that the fracture of the base of the glenoid could not be reduced except by an open operation.

Kellogg Speed recommends reduction of these fractures but states that the functional result following open reduction is no greater than one usually obtains following nonoperative treatment. Conservative treatment was employed rather than an open reduction. X rays three months later revealed complete healing without any change whatever in the original position. The patient presented a normal range of passive motion and function was complete so that he could be discharged to full military duty before the end of four months.

Another patient with a similar injury was admitted to the hospital shortly after the admittance just described. The treatment was similar and the end result was just as good. In both of these cases of severe comminuted fracture of the base of the scapula with marked displacement of the glenoid strong traction was applied without improvement of position. Both patients went ahead to complete recovery of function. An ill advised open operation would not have improved the end result. Although the x rays taken after complete healing still showed a bad reduction these cases were not suitable for reconstructive procedures.

SPONDYLOLISTHESIS

Spinal fusion for spondylolisthesis in the soldier is rarely indicated. The condition if present practically always exists prior to entrance in the Army and furthermore these soldiers may seldom be restored to full duty following operation. An acquired spondylolisthesis must be accepted as a rare entity. The condition is usually congenital and is often asymptomatic until the patient sustains a minor back injury.

CASE IX (Fig. 164)—A thirty seven year old soldier with eleven years of service was admitted because of disabling low back and right leg pain. The back pain began four years previously following a fall during a physical contest and had increased in severity. The pain in the right leg began six months prior to admittance and there were definite symptoms and findings referable to the right fourth lumbar nerve root. X rays showed a second degree spondylolisthesis between the fourth and fifth lumbar vertebra. As the soldier had highly specialized skills and was of definite value to the service an operation was thought indicated. It was believed that the spondylolisthesis was congenital in origin but had definitely been aggravated by military service.

A right unilateral laminectomy of the fourth lumbar vertebra was performed by the neurosurgeon and definite evidence of sequester tissue with compression of the nerve root was found. This was relieved and at the same time a spinal fusion was

done using a large tibial graft and multiple bone chips over the left laminae. Additional fixation was obtained by a Wilson plate attached to the spinous processes of the third fourth fifth lumbar and the first sacral vertebrae. The position of the patient during the operation caused reduction of the spondylolisthesis and the Wilson plate maintained the reduction postoperatively. No plaster immobilization or brace was used.

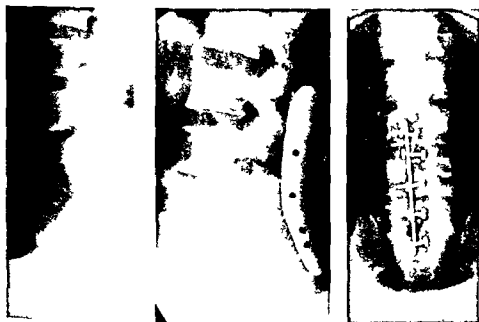


Fig 164 (Case IX) - Second degree spondylolisthesis between fourth and fifth lumbar vertebrae following fall in ju jitsu contest. A Preoperative B Postoperative. Note spondylolisthesis reduced. C Postoperative. Note bone graft on left laminae.

Satisfactory fusion occurred as demonstrated by x rays and the patient has been entirely free from all back and leg pain for nine months postoperatively. He was returned to duty eight months after the fusion and follow up a month later revealed no disability. The patient is able to perform full duty in the infantry.

SUMMARY

- 1 Certain reparative orthopedic problems were selected because they show the importance of individual study and evaluation of each case.
- 2 As septic compound fractures comprise the majority of the cases seen in our hospital special consideration has been given to a more or less standardized approach to this problem.
- 3 Some of the fundamental principles in bone grafting operations with particular attention to the preoperative care of the patients have been described. Strict adherence to these surgical fundamentals has been found necessary in order to restore maximum function.
- 4 A careful reconstructive procedure which is well planned to ob

tain a definite end result will prevent unnecessary or ill advised surgery which is likely to result in no improvement or a complete failure

5 The disabled soldier must be restored as completely as possible and in the shortest length of time and this review is presented in an effort to show the principles and end results which tend to accomplish these ideals

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AMPUTATIONS

JOHN J MOORHEAD MD DSc FACS*

LIMBS and phalanges are less often removed today than formerly. This is largely because the element of infection has been largely controlled by debridement of the wound and the use of the sulfa drugs and penicillin. In addition, damage to some of the main vascular channels can now be corrected by vessel suture or even by the introduction of a vitallium or other type of cannula.

INDICATIONS FOR AMPUTATION

The indications for amputation may be outlined briefly as follows:

1 *Irreparable damage to (a) vascular structures (b) soft part structures (c) bony structures or (d) neural structures*, or a combination of two or more of these factors. These conditions arise ordinarily in compound fracture or in crushing wounds of the soft parts.

2 *Infection involving the soft parts or bone*. Such infection may appear as an immediate sequence or it is represented by osteomyelitis as a later or terminal factor.

3 *Disease processes, such as arteriosclerosis, diabetes or tumor*. This necessity may arise independently of injury or the disease process may be aggravated thereby. Oftentimes the relationship of trauma is extremely doubtful, particularly when the injury is remote or has been of a minor type.

4 *Deformity causing growth disability* as from contractures sequential to wounds, burns, fractures or infection. Congenital deformities are also in this group. I recently amputated an arm because of a Volkmann's ischemia following an elbow fracture sustained many years previously.

5 *Economic reasons* wherein prolonged disability and uncertainty can be exchanged for assured recovery by the sacrifice of a phalanx or of a limb.

Morale—Morale has to be considered, however, before consigning a patient into the amputee class. It means something to be singled out as that man with his leg off. For the individual is immediately set apart or discriminated against from an economic as well as from a social standpoint. This handicap is often visited upon the immediate family as well. However, there is no need for gloom over the prospect.

The illustrations and a portion of the text of this article are from the author's forthcoming book, *Clinical Traumatic Surgery*, to be published by the W. B. Saunders Company, Philadelphia.

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of losing an arm or a leg thousands of amputees have learned to surmount the affliction in such a manner as not to impair their earning capacity or station in life. Large numbers of men in World War I and unfortunately many in World War II are in the amputee class.

The Will to Get Well—In the treatment of any victim of severe trauma the will to get well is an important element. In an amputee it is practically a necessity. The modern prosthesis, especially for the lower extremity, is extremely efficient and there are a considerable number of amputees who are going about their daily work almost as well as if they retained a normal limb. Even in sports, baseball and in football particularly, an amputation of a leg or thigh has not impeded athletic prowess. I know of one man with an amputation of the leg who still goes about his work actively as a landscape expert and is agile enough to climb a 40 foot ladder or swing himself to the top of a high tree.

RULES IN AMPUTATION

The Time Element—Immediate amputation is indicated usually to prevent gangrene or infection, to avoid added hemorrhage or to prevent additional shock. Such amputations are usually performed when shock has been brought under control. In this connection it is pertinent to remember that no major operation should be performed unless the systolic blood pressure level is 90 or over, the main exception being when hemorrhage cannot be controlled prior to the operative procedure.

Intermediate amputation is indicated usually to curtail gangrene and infection or to overcome secondary hemorrhage and shock. Such an amputation is, as a rule, performed days or weeks after the onset of the injury.

Late amputation is indicated generally to control gangrene and infection and for plastic, cosmetic or economic reasons. Here the amputation is ordinarily a later event and frequently is not performed for a long time after the initiating injury.

The Zone Element—There is a place of election for the upper as well as for the lower extremity and these levels are selected because of anatomic considerations and also because of the greater efficiency provided for limb fitting (Figs. 165 to 168). Except as to the fingers or toes, amputations through joints are avoided because joint surfaces afford insufficient coverage and are poorly adapted for prosthesis. In the larger joints, such as the hip, knee, shoulder and elbow, it is necessary to preserve from 3 to 6 inches of the bone if we expect to retain joint motion. If we cannot conserve this amount, it is very much better to amputate above the joint. Experienced surgeons avoid amputating in any area not well covered by soft parts; for example, the lower one third of the leg is a poor zone because it lacks adequate coverage.

The Shape Element—Fancy or intricate amputation flaps are no longer in vogue. For this practical reason most amputations are of the circular flap type or a quadrilateral flap type. In the lower extremity it is necessary to keep the scar from the stump end in order to prevent pressure and thus an effort is made to have the scar on the posterior surface.

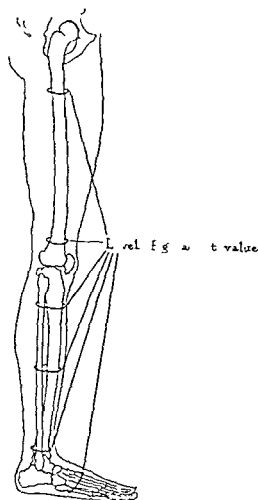


Fig 165—Level of greatest value in amputation of a leg from a functional and limb-fitting standpoint

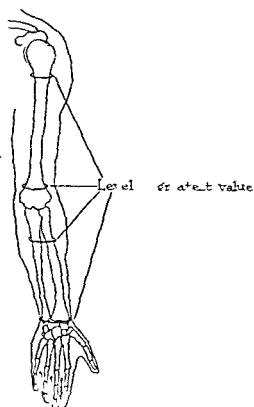


Fig 166—Level of greatest value in amputation of an arm from a functional and limb fitting standpoint.

The Stump Element—The distal end should be well padded and the skin and soft part coverages should be movable and free of adhesions. Every effort should be made to prevent inclusion of nerve ends in the scar so that painful stumps or actual neuromas may be avoided.

Bone ends should be smoothed so that prongs or exostoses are less likely to occur. These appear as a rule in the femur and tibia and they have a tendency to curl upward becoming sources of irritation and eventual ulceration and infection. They occur most often in the presence of infection.

End bearing stumps are not as desirable as side bearing stumps. In the thigh for example the major weight of the artificial limb will be

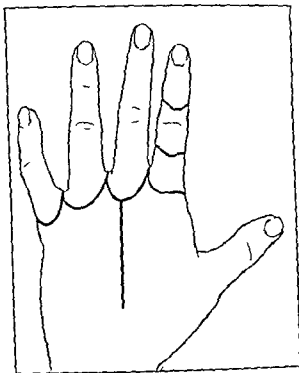


Fig. 167—Amputation site for fingers and middle metacarpal (Modified from Orr)

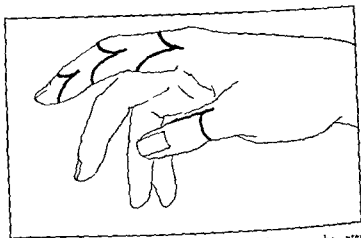


Fig. 168—Amputation of the fingers. Note the long flap is on the outer surface (Modified from Orr)

carried on the tuberosity of the ischium and the great trochanter. In the leg weight carrying will be transmitted to the head of the tibia.

and for that reason it is often advantageous in high amputations of the leg to remove the entire fibula

The Emergency Element—The chop guillotine or sausage amputation is used in warfare and in civil accidents when the question of saving life is the most important element Shock hemorrhage and infection are the three main indications for this type of amputation The name arises because the limb is removed without any definite flap formation and oftentimes all the tissues are cut on the same level Modifications sometimes are possible whereby the skin can be somewhat longer than the underlying muscle layers or the bone

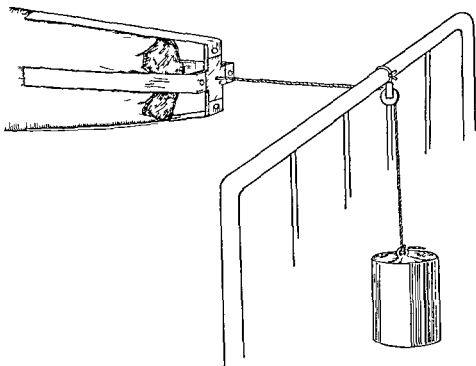


Fig 169—Adhesive traction to be used after chop sausage or guillotine removal of limb An elastic mesh bandage from above down adds to the traction

Usually the emergency is so great and the type of infection is so to be feared that the amputation stump is left entirely open Within a few days traction strips of adhesive plaster can be applied to the skin leading to a cord and weight so that coverage of the stump is provided (Fig 169) It is surprising to see how much coverage can be obtained by these means In other cases it may be necessary later to perform an amputation higher up or to readapt the flap formation to provide better coverage At times it is possible to modify the process to bring it within the field of a definitely planned procedure

Various stages in amputation technic are shown in Figures 170 to 175

Circular Flap Method—The following are the steps in the technic of the circular flap method of amputation

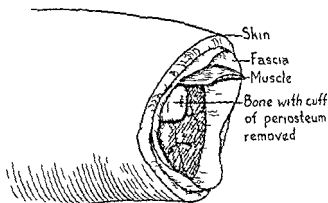


Fig 170—Relation of the amputated overlying structure to the bony stump and the method of coverage (Figs 170-175) are from *Amputations* by courtesy of the author Surgeon General Kirk.)

1 Tourniquet or hand control

Circular incision of all layers down to the fascia

3 Skin flap retracted and muscles severed by a circular sweep to the bone level making the skin flap at least 1 inch longer than the muscles

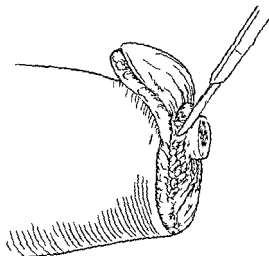


Fig 171—Removal of periosteal cuff

4 Retract the muscles and saw the bone on a level 1 inch above the muscular zone. Most operators prefer an apertosteal bone end rather than to strip up the periosteum and use it as a coverage for the

end of the bone Hence the periosteum is pushed up just beyond the saw line before the bone is removed

5 Secure the vessels

6 Identify the main nerves and cut them off above the level of the muscles In some cases injection of the main nerves before muscular

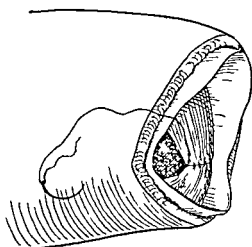


Fig 172 -Suture of the muscles

severance is said to prevent shock Saline solution alcohol or novocain may be used for this purpose My own practice is to pull the nerve out clamp it about an inch from the lower end cut it off below the clamp sew it back on itself or bury it in the depths of the muscle

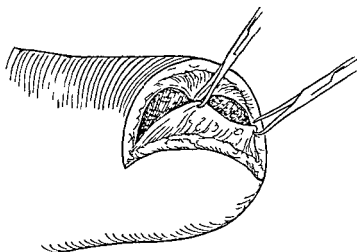


Fig 173 -Fascial coverage

I have not noted any special antishock advantage in the injection of the nerve preliminary to severance of the surrounding parts

7 Sew the muscles over the bone end *making sure that no bony prongs project* In the case of the tibia be sure that the anterior triangular surface has been smoothed off so as to avoid pressure and

if any part of the fibula is retained this bone should be secured at least 1 inch higher than the tibia

8 Coapt skin and subcutaneous tissue with nonabsorbable material interrupted sutures being used

9 Drainage depends upon circumstances. If drainage becomes necessary the drain is inserted at each angle of the wound and is composed of rubber tissue or twisted strands of nonabsorbable suture material

10 Apply a heavy dressing of gauze and cotton and avoid pressure over the edges of the flaps

11 A posterior splint may be applied to maintain the knee or the elbow in extension

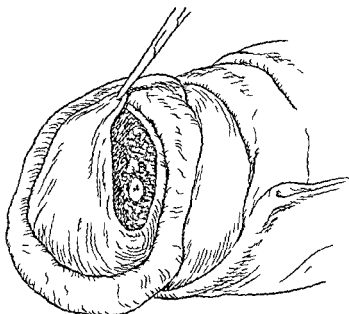


Fig. 174—Facial overlapping

12 Redressing will probably be needed within a few days at which time the drainage should be removed. In some undrained cases it is possible to postpone the redressing for ten days or more

Quadrilateral Flaps—The edges of a quadrilateral flap may be rounded or square and the anterior is generally made longer than the posterior. The combined length of both flaps slightly exceeds the diameter of the limb. In some cases the wound may be the determining factor as to the available use of the flaps and considerable ingenuity must often be exercised to provide a suitable coverage so that after healing adhesions and puckering are avoided

Quadrilateral flaps taken either from the anterior or posterior or from the lateral margins should fit snugly and every effort should be made to have the bone at least 1 inch from the skin edge. The steps

of the procedure are practically as already outlined in the preceding section remembering that the incision begins slightly above the level of the proposed bone removal

Special Flaps—*In the foot* practically all the amputations that we were taught to carry out as students have been abandoned because they provide a support much inferior to a leg amputation. The Syme amputation is still regarded with favor by some surgeons but the technic for its proper performance is difficult and in my belief the outcome is far inferior to a well performed amputation of the lower leg

In the knee the Stephen Smith and the Gritti amputations are still well regarded by some while others prefer the Callander procedure. My own preference is for amputation of the lower fourth of the thigh that is in the supracondylar region

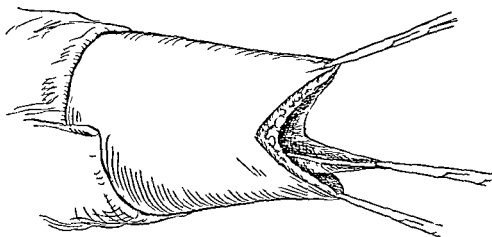


Fig 176—Fascial and skin closure

HAND AND FOOT—Here conservation should be the absolute rule inasmuch as the blood supply is usually ample and the necessity for salvage is paramount. *Aim to save the outer side of the hand and the inner side of the foot*

The order of value of the fingers is index thumb little ring and middle fingers. In combinations the thumb and index exceed all others.

In the fingers a sliding graft made *in situ* will oftentimes provide a satisfactory coverage and the aim is to place sturdy skin on the anterior surface. If the middle finger is to be removed it is frequently better from the cosmetic and utility standpoints to remove the head of the adjacent metacarpal.

The big toe is the most valuable. Next the fifth toe and it is to be remembered that weight is carried in the main on the base of the great and fifth toe and the heel. In amputations of the foot this carrying triangle should be kept in mind.

The stump end of a finger or toe is often tender. This may be due

to a bony spur nerve inclusion or an adherent scar. Revision of the stump may be necessary. I have one case in which I have twice revised a finger tip only to conclude finally that the alleged pain was a neurotic complex and not an actual reality.

AFTER CARE

As soon as the sutures are removed hardening of the stump should begin. This can be started by exposure of the stump to the open air or electric light. Soon this is followed by definite self massaging of the stump and later the patient is taught to bring the stump end rather sharply against a broad surface such as the seat of a chair. The skin can be hardened by using an ounce of powdered alum to one pint of water or a dram of zinc sulfate to one pint of water. It is important to have the patient activate the muscles above the stump level by definite exercises notably in leg amputations where the integrity of the quadriceps is particularly important.

ULCERATION

Stump ulceration is an index of pressure either from *within* due to a bony prong or from *without* due to prolonged contact with some part of the prosthesis. The former or the ulcer of intrinsic origin may also arise from a neural source indicative of a trophic disturbance.

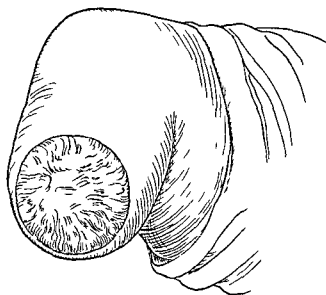


Fig 176—Ulcerated area debrided and ready for graft (Figs 16-180 are from Amputations by courtesy of the author Surgeon General Kirk)

The extrinsic ulceration may arise from such a simple thing as a wrinkled stump sock, a slipping of the stump sleeve or undue pressure because the sole or heel of the shoe is worn unevenly.

Whatever the etiologic factor prompt recognition is necessary and heed must be given to local pain redness or swelling because these

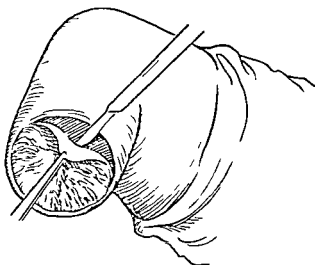


Fig 177—Excision of ulcerated area preliminary to grafting

are the initial signs of impending mischief. If the pressure is relieved before the skin breaks ulceration will be prevented and perhaps operative disability avoided. The operative steps are shown in Figures 176

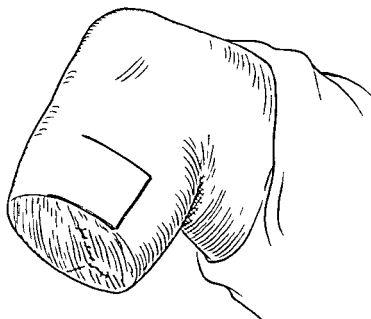


Fig 18—Outline of pedicle graft

to 180. It is especially necessary to be on guard in diabetics and arterio-sclerotics because reparative power in this group is already much impaired.

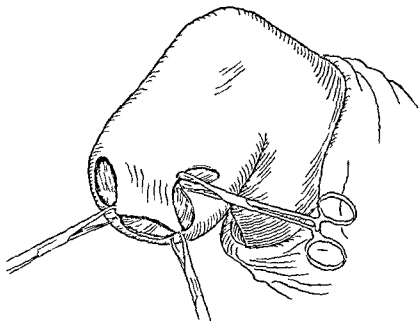


Fig. 179—Coverage of an ulcerated stump by excision of the affected area and sliding pedicle graft

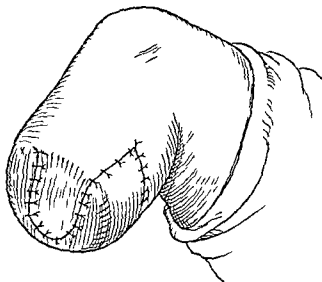


Fig. 180—Sling graft coverage

PROVISIONAL PEG LEG

A provisional peg leg should be applied just as soon as the stump end in an amputation of a lower extremity responds favorably to purposeful massage. In some cases this period is reached within a few weeks.

The simplest form of peg leg is a broomstick stuck into a bucket or cone of leather. A better type is to make a plaster of paris mold of the stump and use this as a model for the bucket or cone to which may be attached the lower end of a crutch providing the so called Pylon type of provisional peg leg (Figs 181-182). In some cases it may be necessary to apply a shrinker which is usually made of stiff muslin or an elastic bandage the idea being that edema is

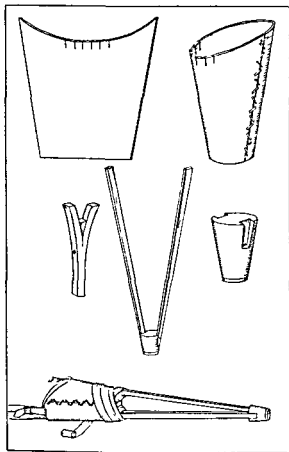


Fig 181—Temporary peg leg with a leather plaster or plastic bucket

prevented by the application of such a constricting agency to the stump end. Ordinarily this is not needed if the above activating process is started immediately.

ARTIFICIAL LIMBS

For the lower extremity these are made of wood usually willow and in some cases metal is chosen customarily duraluminum. The objection to this last is that it is light in weight but heavy in expense. A satisfactory device weighs approximately 6 pounds. The cost of an artificial leg ranges from \$75 to \$250.00. Careful fitting is necessary and the patient should be cautioned against pressure on the stump.

may be used by any patient unable to use the remaining hand for writing purposes or when a bimanual amputation exists. The trained amputee becomes extraordinarily adept by practice and many of them are almost as skilled with the artificial as with the normal limb.

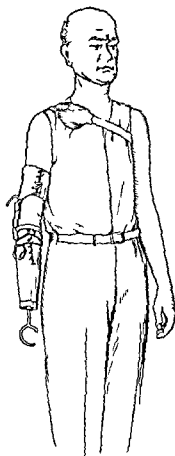


Fig. 185 - An patient of arm for arm holding hook device which can be employed to hold or hold objects

CINEMATIC OR MOTORIZED STUMPS

Cinematic or motorized stumps are adaptable chiefly for the upper extremity and here the object is to bring cut tendons through the overlying skin and to these hooks or cords are attached which in turn lead to an articulated prosthesis. I have seen some of these cases and in cooperative patients the outcome is extraordinarily dramatic. For details see the clinic by Captain Arthur Kessler MC USNR published simultaneously with this paper.

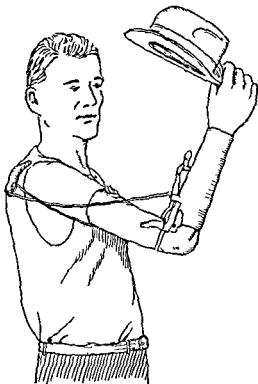


Fig 186—Amputation of arm with artificial activated device

PAINFUL STUMPS

After an amputation of a leg or an arm the patient is quite likely to complain of pain in the foot or hand respectively. So called phantom pains are difficult to overcome and in some cases weeks or months may pass before they disappear.

In World War I and to a lesser extent at Pearl Harbor I adopted the plan of telling the amputee to select six windows in the ward and each night to throw one finger or toe out of a selected window and on the sixth night to throw away the entire hand or foot. Strange as it may seem this concentration or diversion or psychiatric endeavor worked and I have done the same thing effectively in civil cases.

An actually painful stump should give clinical evidence in the form of adhesions, swelling, localized tenderness or cyanosis. In addition many of them on roentgenologic examination will show irregularity or prong formation in the bone especially if the pain is said to persist after the prosthesis is removed. We must however be on guard for the existence of a psychoneurosis of the typical post traumatic variety. If in such a suspected case enough novocain is injected actually to cut off sensation and the patient still complains we may be reasonably sure that the condition is psychic and not physical.

NONTRAUMATIC CONDITIONS

Arteriosclerosis diabetes and tumors are often indications for amputation. With such persisting or coincidental conditions it is often times asserted that a slight trauma is the starting point for ulceration, infection or gangrene. Such assertions are justified in some cases but should not be unreservedly accepted inasmuch as the underlying disease situation is often in and of itself of a progressive character.

Patients known to be suffering from arteriosclerotic or diabetic conditions should be cautioned as to the harmful effects of even trivial injuries and warned against amateur chiropody.

In the case of arteriosclerosis or diabetes affecting the foot, with a spread of infection or gangrene above the level of the ankle it becomes frequently a matter of great judgment as to whether the limb should be removed below or above the knee. Generally speaking in such cases amputation above the knee offers the best prospect because if the limb is removed below the knee the chances of anterior and posterior tibial vitality may be compromised enough to imperil circulation and thus a secondary amputation may become necessary.

ANESTHESIA

The question of anesthesia under such conditions becomes extremely important. Most observers are of the opinion that ether is the best medium when spinal anesthesia for some one of a variety of reasons may be inappropriate. Block or local anesthesia is usually inapplicable in disease processes and as a matter of fact has very little place in any type of amputation.

Refrigeration anesthesia is apparently making a definite place for itself. Those who have employed it are particularly enthusiastic over its merits in the poor risk case as in the presence of arteriosclerosis and diabetes. The advantages appear to be that little or no anesthesia of any type is required and that the repair process is active. Personally I have had no experience with this method.

CINEPLASTIC AMPUTATIONS

CAPTAIN HENRY H KESSLER

MEDICAL CORPS UNITED STATES NAVAL RESERVE

PRELIMINARY CONSIDERATIONS

THE first steps in the rehabilitation of the amputee are to remove the stigma created by the defect and restore the individual's ability to perform gainful employment. Contrary to popular notions the physical and vocational disabilities associated with the amputation are not so serious. Through safety factors within the physical and mental personality the amputee can invoke hidden talents and compensate for those that are lost. These abilities lie submerged like an iceberg ready to spring into action when the emergency arises and reveal their potential value.

Public Prejudice—The greatest hurdle for the amputee is the truculent attitude of society which condemns him as unproductive and useless. This attitude is one that has remained as a vestige of the primitive fear of the unknown and unexplained. Deformity is still associated in the minds of men with the Devil, Malignity, Sin and Evil Spirits. Through the medium of prosthesis however the illusion of wholeness or normality is restored. There is no deviation or inconsistency in appearance to incur this intuitive prejudice. The artificial limb not only hides the defect but may also provide limited and occasionally complete restoration of function.

Amputations of Lower Extremity—There are very few individuals with below the knee amputations who are seriously handicapped. They carry out the full measure of the routine pursuits of life in industry and in their private lives. Many of those whose amputations are above the knee behave in a similar category although in this instance the loss of the natural articulating knee mechanism becomes a serious impairment to a sizeable number of persons. In general however prosthesis in the lower extremity serves a useful purpose in that it can easily replace or duplicate the function of weight bearing that has been lost.

Mechanical Arms—The outlook for the arm amputee on the other hand is not so good. The artificial limb performs the useful psychological purpose of filling the empty sleeve and hiding the defect. It fails however in the ability to reproduce the function of prehension that

From the U S Naval Hospital Mare Island California

The opinions or assertions contained herein are the private ones of the writer and are not to be construed as official or reflecting the views of the Navy Department or the naval service at large.

has been lost. Yes, it can be imitated, but unlike the lower extremity it cannot be duplicated. It is for this reason that so many arm amputees discard their artificial arms after a comparatively short trial. Many persevere, but ultimately refuse to wear the limbs because they find them heavy, awkward and unnatural. They are thoroughly disappointed in not being able to achieve even a close approximation to normal use. They are especially disillusioned by their inability to duplicate the clever performance of the artificial limb salesman who has attained artistic perfection through years of practice and training. These were the conclusions obtained from a personal survey of 76 persons with arm amputations; only 12 per cent of whom wore their arms for cosmetic reasons and only 2 per cent actually used them. In a survey made in Germany after the last war, only 18 per cent (129) of a group of 7000 arm amputees wore a mechanical arm.

Artificial arms have had a long development from the remarkable contrivances produced by the armorers of the middle ages down to the modern manufacture of arm prosthesis. They all fail for two reasons:

In the first place, it is beyond human ingenuity to duplicate the intricate and dexterous function of the hand and fingers. Attempts have been made by means of ingenious devices such as hooks, claws, magnets, chucks and artificial hands to provide this function with little success.

In the second place, these devices are operated by means of springs, cords and pulleys calling into play certain complicated and unnatural actions which make it difficult for the individual to adjust himself. For example, in opening the hook, claw or hand, the actions follow the difficult pattern of a set of mechanical gears. The muscles of the opposite shoulder must go into first gear in order to overcome the inertia and resistance of the closed hook or claw. This is a complicated movement in which the shoulder must first assume a fixed position and then be immediately followed by intense muscular effort. The next muscular effort simulates the action of a second gear in that it follows through the first movement with sufficient power to open the hook widely enough to encircle the object to be grasped. At this point the smoothness of this muscular effort is disturbed by the necessity for a braking action to provide the exact amount of force necessary to keep the hook from closing until the object is completely encircled. Finally, there is a release of muscular effort so that the spring or elastic on the hook will permit the hook to close in on the object to be grasped.

This is a series of complicated acts which is not ordinarily called into play in normal physiological action. While it is true that these movements can be performed efficiently with considerable practice, amputees nevertheless rarely achieve the naturalness and efficiency of normal muscle action by this method.

Prehension—The natural prehensile function of the hand cannot be reproduced artificially. It can, however, be duplicated by means of

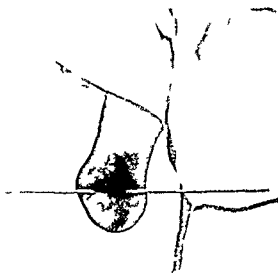


Fig 187—The Krukenberg operation permits natural grasping function by the approximation of the two fingerlike elements



Fig 188—The radius and ulna are clothed with muscle and skin. The preservation of normal tactile sensation is an added advantage

two fingerlike elements in the Krukenberg or *forcipization* operation (Figs 187 and 188). Here the forearm is split into these two elements the radius and the ulna each clothed with muscles and skin in such a

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asked to contract the muscles which flex and extend his fingers or wrist. The site of the flap is outlined with a dye and is generally placed over the area of widest muscular excursion. This excursion occurs as a result of the elongation and shortening associated with muscle contraction and relaxation. This varies from $\frac{1}{4}$ to $\frac{3}{4}$ inch in

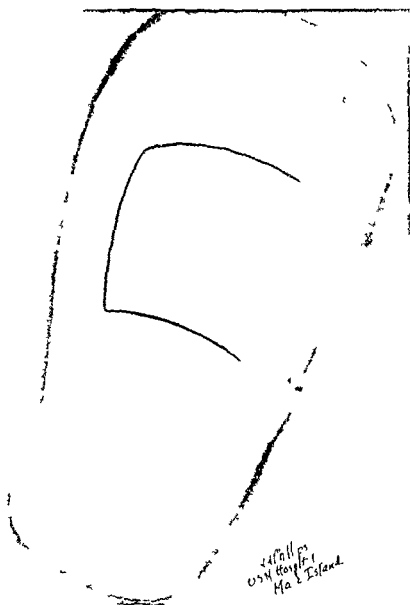


Fig 189—A three sided flap is outlined each arm $1\frac{1}{4}$ to $1\frac{3}{4}$ inches long with the base on the ulnar side of the forearm

the forearm flexors to 2 inches in the biceps muscle. The excursion of the extensors of the forearm or the triceps in the upper arm is generally limited rarely exceeding $\frac{1}{2}$ inch. These extensors act more like springs than active motors. As a rule the proximal arm of the flap each arm of which is about $1\frac{3}{8}$ inches long comes to lie at the junc

The muscle is then canalized after two parallel incisions are made through the muscle sheath by means of an obturator or large straight scissors (Fig 191) On the volar side of the forearm the flexor sublimis digitorum is canalized and on the extensor aspect the extensor communis digitorum muscle is treated in the same manner The canal runs

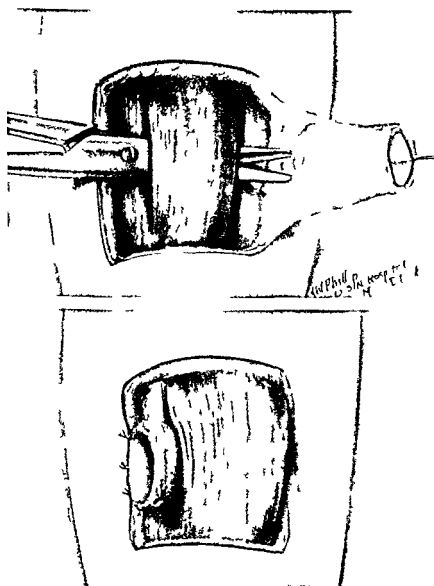


Fig 191—*Upper* The superficial third of the muscle is canalized by scissors or obturator *Lower* The skin tube is passed through the muscle canal and the mouth of the tube secured to the adjacent skin

through the muscle and not the tendon On the volar side the tendon of the flexor carpi radialis and the palmaris longus will frequently be included in the motor in long forearm stumps These tendons however lie in the motor and are not pierced by the skin tube Care must also be taken to canalize only the superficial third of the muscle

Deeper penetration misses the superficial flexors and runs across several short muscles with less muscular excursion and numerous intermuscular septa interfering with good function of the motor. Deep placement of the motor also causes pain on use because of pressure of the skin

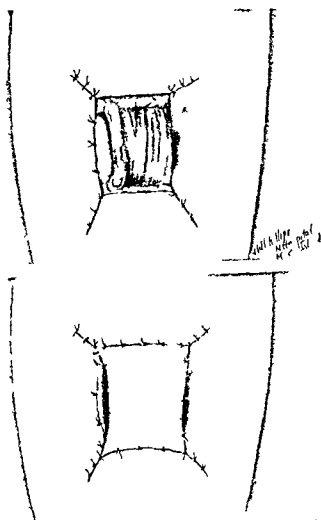


Fig 19 -Upper The wound is reduced in size by approximating the corners without undue tension. Lower The rest of the superficial wound is covered with a split thickness graft.

canal against the underlying bones. Pressure necrosis is an added danger in the deeply placed canals.

When the canal is completed the tube is drawn through with curved clamp care being taken to provide adequate room for passage. The mouth of the tube is then sutured to the adjacent skin (Fig 191). Several sutures are taken in the corner of the superficial

wound atop the mobilized muscle but no attempt is made to close the wound (Fig 192) A split skin graft is adequate for this purpose. Veroform or petrolatum gauze wicks are placed in the canals and a

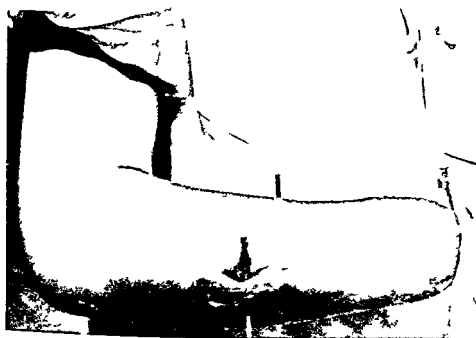


Fig 193—Introduction of pegs in recently healed canals

pressure dressing applied. The first dressing is done in ten days. After three weeks the pegs are introduced (Fig 193) and resistive exercises are begun. Ace bandages are used as in a leg stump for shrinking and

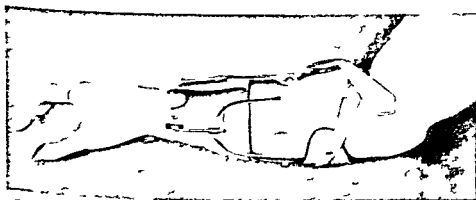


Fig 194—Cineplastic prosthesis for forearm amputation—dorsal and volar motors attached by pegs and levers to hand mechanism—no apparatus required above elbow

for establishing venous circulatory equilibrium. By the end of six weeks this has been accomplished. A plaster mold is made of the stump with the pegs in situ from which the arm is built. The arm may be used immediately although it is sometimes necessary to make

fine screw adjustments in the levers that run from the p.c.s. to the hand mechanism (Fig. 194). In this manner both power and delicate balance can be secured for the reciprocal muscle motors. The artificial hand is removed every night and no other precautions are taken except that of ordinary cleanliness. The canals are kept clean with alcohol or benzine.

EVALUATION

Sufficient experience over a period of fifteen years has been gained to evaluate the utility of the cineplastic operation. While it is not designed for heavy work, it can nevertheless be used for heavy work by appropriate reinforcement of the hand for special tasks. These men and women are engaged in a variety of jobs such as clerk, lithographer, painter, truck driver, machinist, inspector of transmission lines, track foreman, fur sorter, accountant, press operator, needle board repair man, stereotype operator, and so on.

Canals can be made at any site of amputation to within 4 inches of the acromion with practical utility (Figs. 195, 196, 197). In forearm stumps length is desirable. However, disarticulations at the wrist are troublesome. Circulatory troubles are frequent. Fitting over the irregular surfaces of the styloid processes is bothersome. Furthermore, room is required for housing the assembly of the hand mechanism in the region of the wrist. If the hand is not reamputated about an inch above the styloid process of the radius, the affected hand is too long and becomes quite noticeable. Short forearm stumps can be utilized by means of fixation canals. In this case the apparatus is attached to the stump by means of the canal. The entire stump then moves as a unit, advantage being taken of the full power of flexion and extension of the entire stump to activate the hand mechanism.

Of 264 cases approximately two thirds of the patients are weaned and using their arms in the routine pursuits of life, some for fifteen years. Of this active group 90 per cent have had forearm amputations. Patients with above the elbow amputations do not do so well. The loss of the natural elbow articulation is as much of a handicap in the upper extremity as the loss of the knee mechanism in the lower extremity. Despite good control of the hand mechanism by means of the biceps and triceps muscles, the artificial elbow action now complicates the natural psychomotor patterns with resulting incoordination and poor timing. Nevertheless, in select cases with a fine cooperative attitude and in double upper arm cases it has a definite value (Fig. 198).

My own procedure in above the elbow amputations has been to provide the amputee with a standard mechanical arm. If he cannot learn to use it, he will have a difficult time adjusting himself to a cineplastic arm. On the other hand, if he learns to use the standard arm, it will facilitate the ease with which he will operate the other. The

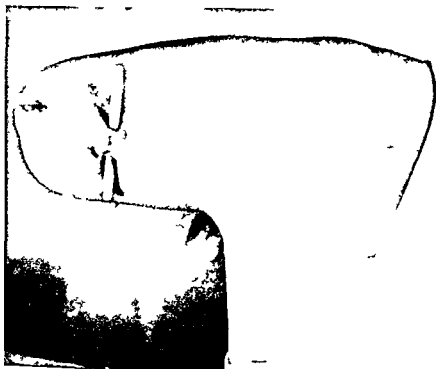


Fig. 195—Upper Triceps motor in short upper arm cineplasty Lower Biceps motor in short upper arm cineplasty

added control of the hand mechanism by means of the direct attachment to the biceps and triceps muscle will provide a wider range of utility than the standard arm can furnish

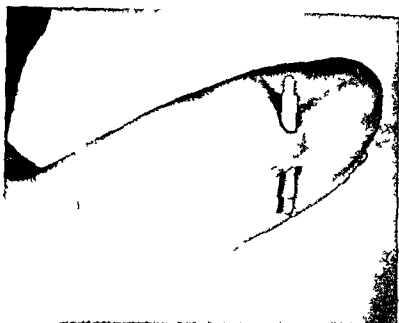


Fig. 196—Biceps motor in upper arm c neplasty

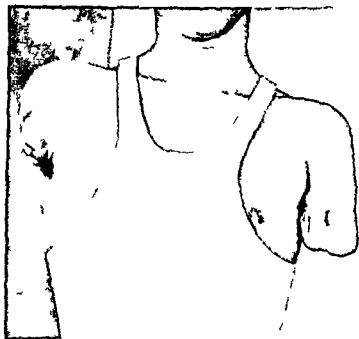


Fig. 197—Double upper arm amputat on Stump n right side t hort f r muscle leverage from c neplastic motors On left arm stump biceps and triceps motors were prepared



Fig 198—Above elbow cineplastic prosthesis Hand activated by biceps and triceps motors



Fig 199—Reeducation of muscle motors in short left upper arm stumps

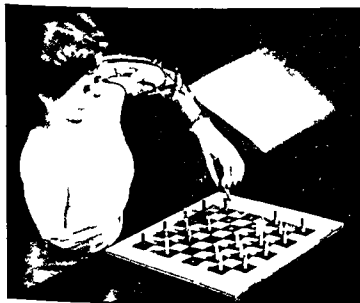


Fig 200—Use of left upper arm prosthesis after training is complete

SUMMARY

The needs of the arm amputee should be analyzed with discrimination. The solution of his social and vocational problems cannot be met by standard formulas. Nor can they be solved if the primary considerations involved are financial. Regardless of cost and time he must be studied with the one end in view, providing him through surgery or prosthesis with the means of increasing his mental and physical powers so that he may be able to meet the competition of those who are free from gross defects.

Many amputees are best served without prosthesis. They use their stumps as paper weights or as propulsive tools or do not use them at all, relying on the overdevelopment of the sound arm in strength and coordination to carry out their functional requirements. The use of a simple strap around the end of the stump acts as a holder in which can be placed any implement from a work tool to a toothbrush.

For the majority of arm amputees more direct help is required to offset social prejudice and provide additional functional assistance. Here a discriminating judgment is required in deciding on the type of prosthesis.

Unless the patient cooperates the best surgical result and the best type of prosthesis will be wasted. The expectations of the amputee are frequently too great. He expects to duplicate the physiologic act of prehension with all its infinite variations. He must therefore be informed of the limitations of prosthesis. Despite these limitations many of the amputees make a remarkable adjustment. This adjustment is facilitated with the cineplastic arm because it depends on a natural physiologic process. Reeducation occurs in a simple manner in a short space of time.

In the manufacture of the apparatus it is important that weight be kept down to a minimum. Furthermore the mechanism should be as simple as possible. The more complicated the prosthesis the less useful is the arm. For this reason it is undesirable to use any more than two reciprocal motors. Triple motors and quadruple motors have been made but my experience has been unsatisfactory in utilizing them to full advantage.

The arm can be designed for heavy as well as light duty depending on indications in the specific case. However if the dominant activity will be heavy duty it is more practical to furnish the patient with a standard mechanical arm with a hook of conventional design.

It is not advisable to perform the cineplastic operation at the same time as the primary amputation. Infection and loss of vitality from trauma frequently complicates healing with failure of the pedicle flap to take.

INTERVERTEBRAL DISKS THE DISK COMPLEX

JOHN J. MOORHEAD M.D., D.Sc., F.A.C.S.*

THERE is a tendency on the part of some observers today to regard the complicated condition of backalgia as settled on the basis of disk displacement. A few experienced surgeons are even of the opinion that an accurate diagnosis can be made by the mere narration of the history; indeed it is asserted that any patient who has pain enough in the back to seek surgical aid is a sufferer from this disk syndrome.

However a note of caution is already being sounded especially since sufficient time has elapsed to follow up some of the postoperative cases. This applies particularly to patients in uniform who can be subjected to rigorous control both before and after operation. Likewise the follow up afforded by industrial medical departments and compensation boards is tending to subdue the enthusiasm of some of the proponents who proclaimed that the removal of a disk afforded complete and speedy cure. Indeed it was asserted by some that even if the suspected disk was not found the exploratory operation effected a cure with or without the finding and removal of a thickened ligamentum subflavum.

The results of introducing a contrast medium into the spinal cord for x-ray purposes is today regarded with disfavor because the material in many cases caused enough irritation to warrant the name "foreign body reaction." Furthermore a patient who knows he has residual material in his spinal canal is not rendered any too happy even though back pain is lessened.

It cannot be too strongly emphasized that *any form of surgery that creates a new form of pathology is not curative surgery*. To perform a laminectomy or even an interlaminectomy and expose the spinal canal is not minor surgery; on the contrary any type of intraspinal operation is a major procedure and should not be undertaken by a novice or an occasional operator.

Recently the term "concealed disk" has been used to account for those cases in which the diagnosis was apparently certain and yet the disk was not found. As to this one writer asserts that if the disk is soft enough to allow the end of a forceps to displace it, then this is a "concealed disk" which should be removed by the curet. There is considerable disagreement, also, as to the necessity for a spinal fusion after the disk is removed. Some surgeons assert that after the removal of the disk fusion should always be done; others say that it is unnecessary and there are those who assert that fusion should be a secondary

operation. Most observers realize that the removal of a disk may render that segment of the spinal column unstable, lead to arthritic changes and even bring about a recurrent type of back pain. The recent type of operation in which little or no bone is removed is said to render fusion unnecessary, but the fate of the remaining segment of the disk is nevertheless problematical.

For a number of years the writer has compared the sacro iliac and lumbosacral syndrome to the semilunar syndrome of the knee. In each a bending and twisting violence is the usual source; likewise a displacement occurs that is often overcome by rest or manipulation. The fat of the knee robbed of a knee disk (meniscus) was once regarded as problematical, but now we know there is a fibrous replacement that provides adequate restoration. The same process may occur in the intervertebral joints when a part of a disk is excised.

This matter of back pain originating in the disk certainly has been a source of satisfaction to the pathists who long ago asserted that there was such a thing as a slipped vertebra and that their manipulation relieved it. There can be no doubt that many times they did just that effectively and often I have benefited certain types of back algia by manipulation. After all the spinal column is an integrated set of joints often amenable to the same type of treatment applied to other and more accessible joints. Most of the disk derangements—90 to 95 per cent of all according to those of experience—occur in the region of the fourth and fifth lumbar vertebrae. There is another group appearing in the cervical area and these are said to account for the radiating pain appearing in the brachial plexus distribution, often regarded as arthritis, bursitis, scalenus anticus syndrome, and even resembling the manifestation of an accessory rib. Some of these seizures have been diagnosed as an anginal or coronary attack and in some cases lasting cure has been attained by the removal of a displaced inter cervical disk.

DIAGNOSIS

Diagnosis is based on the following basic elements, recalling that the process is essentially an intraspinal lesion and indeed the earlier operations were performed on the basis of an intraspinal tumor.

Back pain

Pain in the lumbar region that has resisted ordinary treatment and often is recurrent.

Radiating pain along the sciatic distribution

This may cause pain on the posterior or external (lateral) margins of the thigh.

Neural signs

Reflexes. Knee and ankle jerks are lessened or lost. Sensation is lessened or lost on margins of the legs.

Rise in protein content of spinal fluid to 40 mg or more per 100 cc

Special tests

Straight leg lifting is impaired

Positive Lasegue Patrick and other special tests but these are not especially reliable

X ray

Spinograms of opaque material show distortion at the site of the lesion Aerograms show a similar condition

History of preceding injury

This is not always necessary and oddly enough severe injury is neither essential nor frequent

Of the foregoing diagnostic evidences the most constant set of symptoms seems to be low back and sciatic pain interference with sleep at night, and in some cases accentuation of the pain due to sneezing or coughing The paresthesia appears to occur in about 50 per cent of cases In all cases the variability and intermittency of the symptoms is quite constant Love and Walsh in 500 consecutive cases state that they obtained a history of injury in 58 per cent between 60 and 85 per cent of their patients had pain in the back

DIFFERENTIAL DIAGNOSIS

Lumbago myositis myofascitis arthritis systemic sciatica—all give signs and symptoms resembling the disk syndrome In other words the diagnosis should not be made unless there is a combination of the symptoms already mentioned with or without verification by spinal tap or x ray proof after an air or opaque spinogram has been made

The verification obtained by various tests of the Lasegue Patrick and other types is not particularly impressive

Asymmetrical spines spondylolisthesis and intraspinal tumor usually give motor as well as sensory signs

LOCALIZATION OF VERTEBRAL DISK LESIONS

(Spurling and Grantham)

I THIRD LUMBAR INTERSPACE

- 1 Localized tenderness region third lumbar spine or lamina
- 2 Positive Lasegue and Naffziger tests This last means by occlusion of both jugular veins until the face is flushed pain and paresthesia in the leg appear
- 3 Changes in the knee jerks ankle jerk unchanged
- 4 Hyperesthesia or paresthesia in the distribution of the fourth and fifth lumbar dermatomes

II FOURTH LUMBAR INTERSPACE

- 1 Localized tenderness over the fourth spinous process or lamina
- 2 Positive Lasegue and Naffziger tests
- 3 Unaffected ankle and knee jerks
- 4 Hyperesthesia and paresthesia in the distribution of the fifth lumbar and first sacral dermatomes

III FIFTH LUMBAR INTERSPACE

- 1 Tenderness over the region of the fifth lumbar spine and lamina
- 2 Positive Lasegue and Naffziger tests
- 3 *Diminution of ankle jerk*
- 4 Hyperesthesia or paresthesia involving the distribution of the first and second sacral dermatomes

Most authorities assert that over 95 per cent of all lumbar vertebral disk involvements are at the fourth and fifth lumbar space

Dandy asserts that the diagnosis of a ruptured intervertebral disk can be made solely from the history of low back pain spreading along the posterior part of the thigh or legs with intensification of the pain due to coughing or sneezing. With that statement I heartily disagree.

TREATMENT

The usual measures are tried and if a reasonable period elapses without benefit most authorities advise exploration. This takes the form of an exposure on the affected side through an incision 4 to 6 inches long. The exact site is previously identified by the insertion of a wire suture or by injection of lipiodol or methylene blue and this is an important identification element.

Most operators place a pillow or other support under the prone patient so that the affected area may be arched as much as possible.

Removal of the Protruded Disk—As already indicated originally a laminectomy was done after the usual fashion but more recently experienced operators say that it is unnecessary to remove a lamina or at most only a small section of the lamina needs to be excised. Some operators are able to obtain the necessary exposure by widening the interlaminar spaces.

The protruded disk may be removed extradurally or transdurally depending upon the operative findings. If the extrusion is unilateral, extradural removal is possible but if the extrusion is in the midline transdural excision is preferable. The extruded part may be quite hard but in some cases is soft and fluctuant and if the latter removal by aspiration may be necessary.

In size and general appearance the extruded mass varies. Sometimes it is said to "pop out" while in other cases the mass may be attached by more or less of a pedicle. The diameter of the mass is usually $\frac{3}{4}$ inch or more.

On occasion the disk may not be visible but if a soft spot is noted a small incision is made and Dandy states that if a thin forceps causes impingement and on withdrawal shows flakes of disk material then a concealed disk is certainly present and should be removed by a curet or forceps

Spinal Fusion—As indicated there is much difference of opinion as to the necessity for a spinal fusion. The neurosurgeons quite generally believe it to be unnecessary unless there is some definite evidence of bony instability. If a fusion is done either the procedure of Albee or Hibbs is used. In the former a graft is taken from the tibia; in the latter the spinous processes are used as the graft material.

After Care—In the nonfused cases no special type of dressing is used. In the fused cases some writers believe that a plaster of Paris casing should be applied but the majority believe that this is unnecessary.

In the nonfused cases the period in bed varies from ten days to several weeks during this interval definite exercises are given to activate the muscles of the lower extremity. In the fused cases the patients are kept in bed from four to six weeks or longer.

When the patients are up and about the need for a belt or dressing is in dispute but the majority of operators do not believe in the necessity of any external support.

End Results—These vary. In some cases the relief from pain is dramatic; in others it is only moderate and sometimes the symptoms persist and even become aggravated. Much apparently depends upon the very careful selection of the case and the type of patient. If the element of a psychoneurosis coexists the outcome is likely to be poor. This applies often to patients who have some object in view and is most frequent in compensation and litigation cases.

A number of patients in the military service apparently have not benefited at least during the period that they were kept in service.

Occasionally mishaps occur so that there is interference with sphincter control for a long time; in others damage has been done to such an extent that foot drop and other neurological conditions develop.

SUMMARY

The wave of enthusiasm for operating in this type of case is apparently subsiding owing to the realization that in many cases with classical symptoms the patients spontaneously recover or are benefited by the ordinary type of treatment.

The operation itself should not be undertaken by the inexperienced and as indicated a very careful distinction should be made between the physical and psychic type of patient, avoiding the latter. It is extremely unwise to create a definite postoperative type of pathology for the expected relief of a presumptive pathologic process.

The danger of permitting opaque material to remain within the spinal canal has already been mentioned. If in addition a segment of the spinal column however small has been removed there is always the opportunity for a wishful patient to blame the operation rather than the original condition for the residual symptoms.

PERSONAL OPINION

I have examined and treated hundreds of cases of backache and in my own experience have operated only once for the syndrome of disk displacement. In many of my patients the characteristic signs and symptoms have apparently been present but under the usual form of management not only has the pain disappeared but also such neurological manifestations as changes in the reflexes and the paresthesia.

I am not at all certain that the condition is not congenital or slowly acquired and that it is brought to the attention of the patient and the examiner by some more or less definite trauma.

An analogy between a hernia of a disk and inguinal or any other form of hernia suggests itself inasmuch as trauma is often the accused factor in the latter whereas antedating conditions are in reality responsible.

I know of several instances in which the disk syndrome has recurred at irregular intervals but rarely with the intensity of the original seizure. Some patients have learned by a curious set of maneuvers to relieve themselves thus suggesting that the herniation may be of a pedicle type and when replaced ceases to act as a pain producing factor. In other cases the suggestion is that fibrous tissue forms or there is structural change so that the protrusion becomes smaller fixed and hence less irritating.

I do not believe that we should accept the patient's history plus pain in the back with sciatic irritation aggravated by coughing or sneezing as sufficient for a diagnosis because so many other conditions produce a similar set of complaints. The diagnosis should be made essentially on a set of intraspinal manifestations resembling those of an intraspinal tumor and if relief is not obtained after a reasonable trial of conservative methods then operation is justified if it is performed by an experienced operator.

Every pain in the back does not indicate a protruded disk any more than every pain in the belly indicates appendicitis or every pain in the chest pneumonia.

We should not lose sight of the fact that an intraspinal operation is a major type of surgery and we should not advise patients to undergo any procedure of this sort unless we are reasonably sure that relief cannot be obtained otherwise and that relief is reasonably assured as the outcome of exploration.

The condition unquestionably does occur but that it is common I do

not believe. Even if the diagnosis is proved a reasonable opportunity should be afforded for conservative measures to obtain relief before operation is recommended. It is particularly important to be ultraconservative in dealing with workmen whose livelihood depends upon physical integrity and we should be extremely hesitant in operating on this group because if all does not go well we may inflict a lasting disability by the very act intended to obtain a cure.

After the foregoing was written I talked with Dr. Raphael Lewy, Chief of the New York Labor Department medical organization which passes on many thousands of compensation cases annually. He is of the opinion that this syndrome is often an index of preceding structural instability rather than the sole outcome of an isolated or single injury. The diagnosis is based essentially on neurologic findings plus intraspinal x-ray corroboration. He states further that the postoperative results are very uncertain and in many cases actually have been harmful.

HYPERTROPHY OF THE LIGAMENTUM FLAVUM

These interlaminal bands of yellow elastic tissue blend with the interspinous ligament and help to make up the capsule of the articular facet that forms the posterior margin of the intervertebral foramina. When these bands are involved, as by pain or actual tearing, the disk syndrome is simulated and many of the symptoms resemble those of lumbosacral or sacroiliac sprain, owing to the fact that the spinal nerve roots are compressed by the damaged ligament. There is a very narrow space between these ligaments and the intervertebral disk and this space serves as the route for the passage of the nerves after they exit from the dural canal. Hence any enlargement of a ligamentum flavum may cause root compression. The condition is most often found in the same area in which the disks are found, namely, at the level of the fourth and fifth lumbar vertebrae, and thus the symptoms are similar.

The operative approach is the same as for a disk operation and ordinarily the condition is not suspected until a disk has failed to appear. Then further research may show hypertrophy of the ligament and, if so, it is excised.

It is conceded that the condition is quite rare but, judging from the number of cases in which no protruded disk is found and in which the ligamentum flavum is enlarged, the suspicion is aroused that this condition is being used as an alibi much after the fashion of recurring catarrhal appendicitis in the absence of any other findings to account for abdominal pain and so justify operation.

Personally I have never encountered a case of hypertrophy of the ligamentum flavum and do not agree that a selective trauma is a probable factor in the onset, because trauma to register on this ligament alone must be of a very exceptional nature.

PRINCIPLES OF ANESTHESIA IN PLASTIC SURGERY

VIRGINIA APGAR MD

The principles of anesthesia for plastic surgery are evolved from the requirements of this specialized type of surgery and in occasional cases from the demands of prolonged anesthesia and operation

Fortunately only light planes of anesthesia are necessary for most procedures in plastic surgery This affords the choice of a wide range of anesthetic agents in fact almost every known anesthetic drug has some place in this field Also it is fortunate that the metabolic changes in the patient accompanying a light anesthesia of several hours duration are no more detrimental than a short period of very deep anesthesia Anesthetists especially appreciate the fact that plastic surgeons as a group have developed a high degree of gentleness in the handling of tissues which is so accurately reflected in the conduct of the anesthesia The final choice of the proper agent and technic depends on (1) certain problems peculiar to plastic surgery (2) the condition of the patient and (3) the ability of the anesthetist

The following remarks are made taking for granted the fact that a well trained sympathetic anesthesiologist is available whose understanding of the problems and whose patience match that of the surgeon

1 There should be no distortion of the operative field by the anesthetic technic This applies equally to the infiltration of the operative field with a procaine solution or the distortion of the nose or mouth by a nasal or oral endotracheal tube

2 No technic or agent should be used which increases bleeding in the surgical field The greatest offender in this respect is respiratory obstruction This error is always accompanied by an increase in venous pressure especially about the head and neck and produces almost uncontrollable oozing from the surface of the wound until the obstruction is corrected Equally serious is the use of too small an endotracheal tube in an effort to prevent obstruction for this itself causes an undue narrowing of the air passages The abnormally high blood concentrations of carbon dioxide produced by any respiratory obstruction contribute to the general surface oozing for this drug causes local vasodilatation of capillaries even while producing a vasoconstriction of central origin

There is some question whether an excess of oxygen causes a similar local vasodilatation and increased bleeding In some instances this cer

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tainly seems to be the case for restoration of the gas mixture from one containing a high oxygen percentage as may occur with cyclopropane or ether to one containing between 20 and 30 per cent apparently causes a reduction in the amount of oozing. There is no definite change in the bleeding or clotting time of the blood with any single anesthetic agent properly administered. The injudicious use of a vasoconstrictor drug such as ephedrine or neosynephrin may cause marked increase in bleeding from the accompanying hypertension while the use of epinephrine in local anesthetic solutions seems to assist greatly with this problem. A procaine solution containing 0.1 cc of epinephrine 1:1000 in 30 cc may be used to control bleeding in the operative site even though the patient is already anesthetized with a general anesthesia.

3 Normal muscle tone should be preserved. First plane anesthesia with any of the inhalation agents or a light intravenous anesthesia with pentothal best fulfills this condition. Some plastic surgeons find that the loss of tone accompanying a spinal anesthesia or any other extensive nerve block interferes with the application of grafts. Local infiltration or small areas of field blocks involving only the skin do not interfere with underlying muscle tone.

4 A pleasant induction of anesthesia is imperative. Most plastic surgery patients undergo repeated procedures and anesthetics and a large part of their apprehension regarding future operations can be prevented by a smooth induction of anesthesia which is usually followed by a smooth maintenance and recovery. This is accomplished by the establishment of a good rapport between the patient and anesthesiologist, and individualized premedication which may include tribromoethanol or pentothal.

5 A smooth recovery is imperative so that grafts, pedicles and complicated dressings will not be displaced. It is important for the anesthesiologist to remember to continue the anesthesia throughout the whole period of application of the dressing which of necessity consumes much more time than the usual surgical dressing allowing no movement on the part of the patient until it is entirely secure. The best guarantee to a smooth recovery is good preoperative preparation of the patient with special attention to fluid and glucose intake, the use of anesthetic drugs which produce the least metabolic changes and a smooth induction.

6 The anesthesiologist and his equipment should not encroach on the surgical field within the limits of safety. Probably the greatest error anesthesiologists have made in the past has been to allow the surgeon to dominate the surgical field that control of the airway and thereby the anesthesia is lost. The importance of this fact does not become evident until some patient undergoing surgery about the nose and mouth anesthetized by insufflation of ether and air through catheters placed in the pharynx becomes completely obstructed by accumulation of blood, vomitus or mucus necessitating emergency intubation, resuscitation and even tracheotomy.

CHOICE OF ANESTHESIA

Local Infiltration or Nerve Block—It is true that the requirements of the surgeon for a successful result sometimes strain the inventory and adaptability of the anesthetist but a frank preoperative discussion of the problem by both parties will usually lead to a successful solution. As a rule operations about the nose and mouth in which the preservation of symmetry is imperative should be performed under field block or peripheral nerve block such as mental or infra orbital block. These blocks can be repeated during the operation if the usual limit of one hour and a half is exceeded. The patient's cooperation can best be secured by judicious use of premedication which includes both the barbiturate and opiate drugs. The all important safety factor the cough reflex is active and able to protect the lungs from foreign material. The patient voluntarily swallows saliva and other secretions, and is able to cough up whatever blood reaches the trachea.

General Anesthesia—Endotracheal Technique—The anesthetist is obligated to establish a satisfactory airway by the use of an endotracheal tube in those occasional cases in which the surgeon feels that the patient will be uncooperative even with good premedication for the long period of time necessitated by the procedure and really feels that a general anesthesia is the only choice. With intravenous anesthesia the tube may be more easily introduced after the use of a topical anesthetic drug such as cocaine or butyn. The pharyngeal and laryngeal anesthesia should be thorough as for bronchoscopy.

Many of the problems of endotracheal anesthesia in plastic surgery are well discussed in the recent paper of Gordon.¹ The choice of the nasal or oral route depends on the type of surgery to be performed. In either case the tube in the trachea should be sealed off from the pharynx by an inflatable cuff below the vocal cords or by carefully applied packing around the tube in the hypopharynx. The adapter at the external outlet of the tube should be of such a type that it does not project beneath the drapes in the way of the surgeon's hands. For inhalation anesthesia it is connected by a short stout piece of rubber tubing to a to and fro canister and bag which permit the most satisfactory control of the anesthesia. A second possibility is to connect the short rubber tubing to an empty half pound ether can in the top of which three openings have been made to permit the ingress of air—a modification of the original Flagg technique. The can is kept from one quarter to one third full of ether. Oxygen may be added from a tank by a catheter introduced into one of the openings.

It would be a mistake to infer that endotracheal anesthesia solves all the problems of general anesthesia in operations about the head and neck. The anesthetist must be on guard to avoid certain complications which may accompany endotracheal techniques. The intubation must be skillful and atraumatic. The endotracheal tube chosen should be as short and wide as possible to minimize friction to respiration—

a factor not important in short anesthetics but of prime importance in those of long duration the tube if of the Magill type should not be too soft, if the nasal route is chosen for linking of the tube will occur as the nasopharynx is entered. A large bore tube also assures that a suction catheter can be introduced through the tube into the trachea to remove accumulated mucus and bronchial secretions. A nasal endotracheal tube completely filled with mucus and too small to permit the transit of a suction catheter is much worse than no tube at all. The possible objection that the vocal cords or tracheal epithelium are injured by the presence of an endotracheal tube for several hours has not been borne out by clinical experience. The slight hoarseness which occasionally results is a small price to pay for the safety afforded by the endotracheal tube.

Intravenous Combined With Rectal Anesthesia—There is no ideal anesthetic agent or technic for plastic surgery. Many new ideas are being put into use and more time is needed to evaluate them properly. The combined use of *tribromethinol* and *pentothal* has proved to be of value clinically in some anesthetists' hands although theoretically the simultaneous use of two nonvolatile agents presents many objections. The advisability of using pentothal anesthesia for over five hours is still in doubt, although in some cases it seems highly satisfactory. The restlessness which occasionally occurs during recovery from such long pentothal anesthesia in spite of adequate tidal volume and oxygenation needs explanation.

The too frequent occurrence of voiding difficulties after prolonged continuous *spinal anesthesia* is a serious detriment to the method. The great difficulty in intubating some patients with severe contractures of the chin so that it rests upon the chest only emphasizes the need for training more physicians in these difficult and complicated anesthetic techniques. In the absence of the services of a well trained anesthesiologist the plastic surgeon will probably obtain the best results by the use of local infiltration or nerve block anesthesia.

SPECIAL PROBLEMS

Some of the problems arising in plastic surgery are those pertaining to any long anesthesia and operation. By long we mean over five hours in adults and over two hours in children. If surgery of this duration is necessary the surgeon and anesthesiologist must be cognizant of other problems. An intravenous needle of adequate bore should be in place before the operation starts and *fluids* should be running in continuously. The anesthesiologist is in a good position to determine the type of fluids to introduce during the procedure. Blood grouping, cross matching and blood for a transfusion should be available before operation. Even the most careful plastic surgeon cannot avoid considerable blood loss over this period of time. Too rapid introduction of fluids or too early blood transfusion will cause distressing increase of

oozing in the operative field. The anesthetist's record of circulation and respiration and clinical judgment of the patient's condition are the best guides to fluid therapy.

Meticulous attention to the *position of the patient* is necessary. A small pillow under the lumbar curvature and another under the knees will often prevent postoperative backache. The position of the arms must be such that radial and ulnar nerve pressure are avoided. A foot board to keep the feet at an angle of 90 degrees is indicated. If the patient is to be in prone position the shoulders and iliac crests only are supported by firm sandbags so that the thoracic and abdominal respiratory movements are impeded only slightly.

Difficulty in keeping the patient at an even plane of anesthesia toward the end of a long operation may be due to bladder distention. The anesthetist should ascertain the size of the bladder by percussion, and perform a *catheterization* if distention is present.

It is inevitable that some secretion will accumulate in the pharynx, even with repeated doses of scopolamine or atropine, and a sterile *suction catheter* should be included in the instrument tray and used by the surgeon to keep the pharynx empty in operations about the head and neck.

In operations on the trunk or extremities it is necessary to avoid too much pressure of the face mask on the bridge of the nose and cheeks. Frequent elevation of the mask at this point and gentle massage will keep the skin circulation in good condition.

The anesthetist must remember that depressant drugs and those employed to prevent secretions soon pass their maximum action and should be repeated at intervals by intramuscular or intravenous routes.

In the postoperative period special attention must be given to *hyperventilation* and *frequent change of position* for the prolonged period of immobility increases the hazard of pulmonary complications. The development of decubitus ulcers is more frequent after long operations and the skin over the various bony pressure points must be observed frequently and the position of the patient changed to avoid further pressure.

Since most plastic surgery is elective in nature the condition of the patient is usually good so that it does not influence the choice of anesthetic agent and technic nearly as much as in other types of surgery. If some metabolic disorder such as diabetes exists there is ample time to bring the disease under good control. Chronic anemias should be corrected. The state of nutrition and hydration should be optimal. In plastic surgery under emergency condition only very short procedures should be planned and the state of circulatory depression carefully evaluated before operation is undertaken. In a patient on the verge of shock local or regional anesthetic methods are by far the safest choice since vasoconstriction and other compensatory measures directed against shock are allowed to continue. All general

anesthetic agents interfere in varying extents with such compensatory changes. Spinal anesthesia to levels higher than the lowest thoracic segments will also cause undesirable circulatory changes in such patients.

PREMEDICATION

Premedication should be planned for each individual³ with especial emphasis on psychic depression. Short acting *barbiturates* by mouth such as 0.1 to 0.2 gm of seconal or nembutal one hour before the contemplated operation will best produce a sleepy, nonalert mental state. Before local or regional anesthesia *barbiturates* are also indicated to counteract the convulsant tendency of all regional anesthetic drugs. *Morphine* is the best drug for depression of reflex irritability and is given hypodermically in doses ranging from 0.01 to 0.02 gm ninety minutes before operation. If the dose administered does not seem to be adequate when the patient is brought to the operating floor, an additional dose may be given intravenously. All morphine doses are balanced by scopolamine in a 25:1 ratio. Because of its cerebral depressant effect, its production of amnesia in many cases and its greater drying effect in the presence of irritating anesthetic vapors, scopolamine is preferable to atropine. *Tribromethanol* is often used as premedication in operations not involving the oral or nasal cavities. *Pentothal* may also be used as an induction agent preceding inhalation anesthesia, especially in cases in which it is difficult to apply the face mask snugly without discomfort.

Our ultimate aim is to understand thoroughly the problems of the plastic surgeon and to adapt our techniques to provide him with an optimal surgical field and at the same time never to forget that the safety of the patient is the one most important consideration.

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LOCAL ANESTHESIA IN MAXILLOFACIAL SURGERY

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THE elimination of and the relief from pain have been sought by man for centuries. In early times extracts from plants that contained anesthetic properties were used. Even suggestion and hypnosis were resorted to in an attempt to relieve mankind. Later the application of pressure was the most common method of anesthesia but this method had severe limitations. The use of cold ice and extremely sharp instruments all found their way into the alleviation of suffering.

In the middle of the nineteenth century the hypodermic syringe was invented. A little later cocaine was discovered and found to be extremely useful but its toxic effects were severe. Finally in 1905 procaine hydrochloride (novocain) was produced by Einhorn and since that time rapid progress has been made in solutions and their administration. Through research and actual clinical experiments local anesthesia has developed into an important branch of surgery. The standardization of drugs, their use in combination and refinements in technic of administration are the leading factors in its success.

A good anesthetic (1) should eliminate pain (2) should have a minimum toxic effect and (3) should not interfere with the healing process. I will not discuss the pharmacology of the various anesthetics at this time but will simply review the methods of injecting a solution hypodermically into the region of the face and jaws.

PRELIMINARY CONSIDERATIONS

Classification—Local anesthesia may be classified under three general headings namely infiltration, conduction and topical anesthesia. There are other forms of administration such as subperiosteal and intraosseous but for the average practitioner infiltration and conduction are all that are necessary.

Infiltration anesthesia means the depositing of an anesthetizing solution into and about the area to be operated upon. With reference to the bony tissues of the jaws infiltration is more effective in the maxilla. Conduction anesthesia is more generally used and is more effective in the lower jaw.

Indications—A local anesthetic should be used (1) in prolonged and delicate operations (2) where cooperation of the patient is desired (3) where the operator can be more deliberate and less hurried (4) where the patient objects to the loss of consciousness. With the

exception of certain forms of acute infection I know of no contra indications to the use of a local anesthetic in maxillofacial surgery

Anatomical Considerations—The results from local anesthetics can be most discouraging if the operator is not adequately acquainted with at least the nerve supply of the parts involved. Quantities of solution are not depended upon but rather small doses in the proper places

Asepsis—The importance of asepsis cannot be overemphasized. The introduction of sterile solutions with sterile instruments into properly prepared tissues is demanded of every user of local anesthesia

UPPER JAW

In the upper jaw where a *single tooth* is to be extracted and no acute swelling is present an infiltration or supraperiosteal injection is made directly above the tooth involved. One to 2 cc of 2 per cent procaine solution with adrenalin or cobefrin as a vasoconstrictor is sufficient. Of course a corresponding palatal injection is necessary to complete the anesthesia

To remove *more than one superior molar on the same side* an injection of the posterior superior alveolar nerve is indicated. For this injection the distobuccal root of the superior second molar is used as a landmark for the point of the needle to enter the tissues. The syringe is held at an angle of 45 degrees to the occlusal plane and then carefully directed inward upward and backward until the tissues have been pierced for about $\frac{3}{4}$ inch. Then the solution is injected slowly always watching the patient's color. A supporting palatal injection is made by introducing some solution into the soft tissues of the palate between the second and third molars. Entrance into the postpalatine foramen is not necessary. This posterior superior alveolar injection does not anesthetize the mesiobuccal root of the upper first molar so that a supporting injection over this tooth is necessary if it is to be extracted together with the other one or two molars

The *two superior bicuspid teeth* are supplied by the middle superior alveolar nerve and infiltration anesthesia is usually employed for them

The *superior canine, lateral and central incisors* can be anesthetized by infiltration or a high injection into or about the infra orbital foramen. For infiltration it is only necessary to inject about the apex of the tooth. However an intra oral infra orbital injection can be made as follows. The tissues of the face are held taut and outward from the maxilla. After the tissues have been painted with iodine the syringe is held so that the needle will not come in contact with the maxilla until it reaches the vicinity of the infra orbital foramen. If it is directed inward toward the bone the contour of the maxilla in this region will never allow the needle to pass up to the region desired. The

point of injection should be between the first and second bicuspid. Corresponding palatal injections must be made in the region of the canine and incisal foramina to complete the anesthesia. This type of injection is particularly indicated for large maxillary cysts and impacted canines and for immediate denture work.

LOWER JAW

In the lower jaw conduction or block anesthesia is the method of choice. Here the landmark for the point of injection is made by placing the finger into the retromolar fossa—a depression in the anterior surface of the ramus formed by the internal and external oblique lines. In this way the mesial limit of the ramus is located. By holding the syringe over the opposite bicuspid the needle is introduced into the soft tissues about 1 cm above the occlusal plane and is carried back if no resistance (bone) is encountered to a depth of $\frac{3}{4}$ to 1 inch and no more. Usually at this point the tip of the needle will be in the mandibular sulcus and in contact with the inner surface of the ramus. Here the anesthetic solution will come in contact with the *inferior dental nerve* as it enters the mandible and will anesthetize the jaw to the median line. If anterior teeth are to be removed also a supporting infiltration in the region of the lower central and lateral incisors will be necessary. When only the lower incisors are to be extracted infiltration on both the buccal and lingual surfaces is all that is required. Conduction anesthesia here is unnecessary.

The *long buccal* injection is necessary in the lower jaw to support the inferior dental injection. This injection is made in the buccal vestibule in the region of the third molar and anesthetizes the soft tissues of the intra oral cheek vestibule and gums to the region of the bicuspid.

Injection into the *mental foramen* for anesthesia of the lower anterior jaw is not entirely satisfactory and therefore is not recommended.

Other intra oral injections which may be mentioned at this time are the *incisal* and *postpalatine*. The incisal foramen is easily entered, provided the syringe is held in the same plane as the lingual surfaces of the incisor teeth. The posterior palatine injection is useful for reaching the sphenopalatine ganglion which innervates the nasal and antral linings and soft tissues of the hard and soft palate. By using a thin (25 gauge) long ($1\frac{1}{8}$ inch) needle and introducing it slowly and cautiously into the postpalatine foramen for about 3 cm the sphenopalatine ganglion will be anesthetized.

By carrying out the posterior superior alveolar or tuberosity injection to a greater depth the solution will reach the vicinity of the foramen rotundum and produce an anesthesia of the whole middle division of the trigeminal nerve.

EXTRA ORAL INJECTIONS OF FACE

Extra oral injections of the face are not so commonly employed and in some respects are a little more difficult to make than those described

The *infra orbital* injection is simple. The injection is made easier by staining the skin directly below the pupil about $\frac{1}{2}$ inch below the inferior border of the orbit to provide a landmark. The eyes should be open and looking straight ahead. With the syringe held at an angle of 45 degrees to the face the foramen can be readily entered. It is not desirable to introduce the needle into the canal as it might pierce the superior surface and enter the region of the orbit.

For injection of the *inferior dental nerve* extra orally a point is marked in the middle of the sigmoid notch just below the zygomatic arch. After first anesthetizing the skin a 3 inch 20 gauge needle is introduced and directed inward passing just posterior to the external pterygoid plate to a depth of about 2 inches. Here the solution will be deposited in the region of and directly into the foramen ovale.

Another extra oral method of injecting the inferior dental nerve is from beneath the inferior border of the mandible. The point of needle insertion is half way between the angle of the jaw and the anterior border of the masseter muscle. A landmark on the skin about the midsection of the ramus can be used as a guide for the mandibular sulcus. With the patient's head tilted to one side the needle can be guided along the inner surface of the ramus until the mandibular sulcus is reached.

COMPLICATIONS

Complications occasionally follow the use of a local anesthesia. *Hematomas* and *ecchymoses* occur especially in the tuberosity region. Ordinarily they are absorbed and disappear within two or three days.

Trismus is another complication. This is due usually to an injection of solution into a muscle. It is sometimes one or two weeks before the patient regains the usual movements of the jaws when trismus due to injection occurs.

There are times when quite severe reactions occur immediately following an injection of an anesthetic solution especially if it contains epinephrine. The patient becomes extremely upset and pale, has a rapid weak pulse and cold moist skin and sometimes becomes temporarily unconscious. This immediate reaction is probably due to the injection of solution into the blood stream especially into a vein. That is why it is advisable to watch the color of a patient while injecting the solution. If a change of skin color is noticed the injection is stopped. For undoubtedly the needle is in a blood vessel. In patients with serious cardiac, hypertensive or hyperthyroid disease it is advisable to substitute cobefrin for epinephrine as a vasocon-

strictor in combination with procaine. These patients seem to react kindly to cobefrin and good results have been observed.

The injection of a local antiseptic into an infected area should be avoided. There is danger of spreading the existing infection into new areas thus multiplying the seriousness of the patient's condition.

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THE SURGICAL CLINICS of NORTH AMERICA

LAHEY CLINIC NUMBER

SYMPOSIUM ON POSTOPERATIVE COMPLICATIONS— PREVENTION, RECOGNITION AND TREATMENT

POSTOPERATIVE COMPLICATIONS OF THYROIDECTOMY

FRANK H LAHEY

THE thyroid gland is an extremely vascular organ. It is intimately related to the four small parathyroid glands, the trachea and the recurrent laryngeal nerves. These factors together with the serious state of many patients upon whom thyroidectomy is performed make postoperative complications not only frequent but also extremely dangerous.

HEMORRHAGE

Postoperative hemorrhage is the most serious complication because it quickly can result in death unless it is recognized early and dealt with promptly. There are two types of postoperative thyroid hemorrhage: that which occurs beneath the skin flap, venous in origin, and that which occurs beneath the sutured muscles, arterial in origin.

Hemorrhage beneath the skin flap is rarely dangerous; is never startling; is gradual in occurrence and is easily relieved by the re-elevation of the skin flap and control of the oozing venous point. When the skin flap in subtotal thyroidectomy is elevated a great many veins are encountered. Most of them are readily controlled, but an occasional one may be overlooked and will ooze beneath the skin flap and produce a hematoma. This may be painful and often requires reoperation, but usually does not produce sufficient pressure to interfere with breathing.

When a bulging skin flap and an evident hematoma indicate bleeding beneath the skin flap, it is advisable to take the patient back to the operating room, provided the postoperative reaction is not too severe. The skin flap should be elevated, the bleeding point ligated, and the skin flap put down again in place. In most cases this is infinitely better

than later evacuation of the hematoma which would disturb the scar and might result in infection in the cavity made by the hematoma. This produces unsightly angulation and results in a disfiguring asymmetrical goiter scar about which the patient might be quite unhappy. A hematoma rarely occurs if every oozing vessel is accurately tied, and venous oozing beneath the skin flap rarely results in a situation of any seriousness as far as life itself is concerned.

A hemorrhage beneath the sutured muscles is usually arterial in origin either from the superior or inferior thyroid artery. In no other surgical situation can a life be so dramatically saved by proper management. When following subtotal thyroidectomy there is hemorrhage from the superior or inferior thyroid artery and the prethyroid muscles have been sutured together immediate embarrassment of respiration of the obstructive type will result. This is due to the pumping of arterial blood into the space previously occupied by the thyroid gland, bounded in back by the vertebral bodies and transverse processes and in front by accurately sutured muscle. The respiratory embarrassment progresses rapidly from stridor to cyanosis to complete obstruction.

In our experience with over 23 000 thyroidectomies we have observed several dramatic episodes as the result of this dangerous complication. When one realizes that an arterial hemorrhage in this location occurs into a tight pocket in the center of which is the trachea, one appreciates that the pressure on the trachea is approximately that of a blood pressure cuff about one's arm. It is therefore not surprising that death as a result of tracheal obstruction can occur suddenly unless the muscles are promptly separated, the clot turned out, and the pressure on the trachea completely relieved.

When there is rapidly progressing interference with breathing particularly of the tracheal obstructive type the possibility of arterial hemorrhage beneath the muscle should be investigated immediately. When such a hemorrhage is present the neck is indurated and tense as the result of the increasing clot beneath the sutured muscles and the patient obviously is suffering from high tracheal collapse progressing rapidly into complete asphyxiation. No great evidence of bulging may be present since the hemorrhage occurs into an almost completely tight pocket.

Because of the number of thyroidectomies performed here every staff member and nurse is very conscious of the possible danger in any patient who has recently had a thyroidectomy and whose breathing becomes audible. Every assistant and nurse who cares for patients following thyroidectomy is cautioned never to delay but to obtain immediate help should any evidence of increasing tracheal obstruction and difficulty with breathing develop. In such patients the attention of one of the surgeons is promptly directed to these symptoms so that the possibility of a hemorrhage from the superior or inferior thyroid artery can be investigated immediately day or night.

In approximately a dozen patients in whom these dangerous obstructive symptoms as the result of hemorrhage have occurred they have developed so suddenly and the obstruction has progressed so rapidly that impending death was evident even to anyone walking through the hospital corridors. So desperate and urgent was the situation and so rapid the onset that with no asepsis without scrubbing the hands or putting on rubber gloves these wounds were ripped open the sutured prethyroid muscles were pulled apart and the clots were bailed out with immediate and complete relief of obstructive symptoms. Gauze was introduced with moderate finger pressure to control arterial bleeding until the arterial points could be ligated.

Dr Sara M. Jordan, head of the Department of Gastro Enterology in making rounds through the hospital has been called upon twice to save such a patient's life. Nearly every surgeon at the Clinic has been able by such prompt measures sometimes with the addition of a tracheotomy to save the life of a patient who as the result of sudden arterial hemorrhage and pressure upon the trachea was about to die. Thus familiarity with the seriousness of this situation has permitted us to save the lives of our own patients and also those operated on by other surgeons when the emergency has arisen as we were making visits through the hospital.

Such hemorrhage which is most apt to occur within twelve hours after operation, is probably most often due to slipping of an inaccurately applied ligature of the superior thyroid artery or a branch of the inferior thyroid artery.

Two plans, which have been employed in this Clinic for several years have largely obviated the danger of postoperative hemorrhage. In all cases the inferior thyroid artery now is tied in continuity outside the gland close to the point where it emerges from behind the common carotid artery. This practically eliminates the possibility of secondary hemorrhage from the branches of the inferior thyroid artery which in the past were so often tied within the substance of the gland. No case of tetany has occurred as a result of bilateral inferior thyroid artery ligation.

When the superior thyroid artery is tied and severed as it enters the apex of the upper pole of the thyroid gland it is often severed quite close to the point where the tie is placed about the trunk of the vessel. This is often necessary because of the short length of vessel between the point where the tie is placed and the point where it enters the apex of the gland. This may result in the vessel being cut so close to the tie that with coughing or vomiting the tie slips off.

For some time now it has been our custom after completion of a subtotal thyroidectomy to grasp the ligated stump of the superior thyroid artery with a right angle clamp and to put on another precautionary tie just above the first one thus making doubly certain that secondary hemorrhage from slipping of this tie will not occur.

TRACHEAL OBSTRUCTION

Tracheal obstruction occurs postoperatively not only as the result of arterial hemorrhage but also as the result of edema. In an occasional case as the result of edema in the wound or spreading into the larynx or pressure of the edematous muscle on the trachea, progressive difficulty in getting enough air into the lungs develops.

A generalization regarding immediate postoperative difficulty in breathing which I have repeatedly emphasized as valuable is that whenever one is in doubt as to whether to do a tracheotomy for obstruction and difficulty in breathing that is the time it should be done. In our early experience at the Clinic we unfortunately once or twice permitted a patient who was having difficulty in breathing after thyroidectomy to go through the night in the hope that by morning he would be better. When the tracheotomy was finally done the next day the patient failed to respond and died as the result of prolonged anoxemia.

We are strongly of the opinion that when a patient after subtotal thyroidectomy has persistent difficulty with breathing which interferes with the intake of an adequate amount of oxygen even if it is not due to the type of hemorrhage described a tracheotomy should be performed promptly. The introduction of a tube through which breathing must be done although only temporary is disturbing to the patient and his friends. However if the tracheotomy is relatively low (between the third and fourth rings) no serious postoperative complications result. The tube usually can be removed within three or four days and the trachea closes. The edema by that time has gone down, the patient can breathe regularly and even though the wound is a little distorted it is better to have to revise part of the goiter incision than to expose the patient to the possibility of an avoidable death. We have come to the definite conviction that it is infinitely better if doubt exists to perform an occasional unnecessary tracheotomy than to lose a single patient because of failure to take this precaution.

In our early experience we were often concerned about the possibility of contamination of the fascial planes and the development of mediastinitis if a tracheotomy was performed immediately after operation. However even in patients who have had an intrathoracic goiter removed the cavity within the mediastinum has been packed with gauze and if following the introduction of the tracheotomy tube the wound about the trachea also is lightly packed with gauze there is little or no likelihood of any disturbing local contamination or mediastinitis. We have no hesitancy in doing a tracheotomy at any stage postoperatively when the interference with breathing indicates it. The only warning is that when a subtotal thyroidectomy is performed, the isthmus of the thyroid gland should be removed. This accomplishes two desirable purposes namely it removes an additional amount of thyroid tissue in toxic patients thus making the subtotal thyroidec-

tomy radical but even more important it leaves the trachea bare so that postoperative tracheotomy if necessary is easily accomplished

One should bear in mind that the easiest point at which to do a tracheotomy that is at the point where the trachea approaches the cricoid is also the least desirable. Since this is the narrowest part of the trachea tracheotomy is likely to result in stricture. All tracheotomies in this Clinic are performed below the level of the second tracheal ring usually at the level of the third or fourth

TETANY

Tetany is probably one of the most undesirable postoperative complications of thyroid surgery. It is however distinctly avoidable. In our experience of 23 000 thyroidectomies tetany has not occurred in more than 6 patients. This condition has not occurred in recent years since the recurrent laryngeal nerves routinely have been exposed during thyroidectomy.

If one is familiar with the appearance of the parathyroid glands and knows their most common location and if one has good light adequate exposure and a dry field the glands will not be removed. In most cases the surgeon should be able during operation to demonstrate the location of the parathyroid glands and after subtotal thyroidectomy he should be able to demonstrate that they are intact. Exposure of the recurrent laryngeal nerves with rotation of the thyroid gland so that its posterior aspect is demonstrated which we advocate necessitates such a dry field that the parathyroid glands likewise are demonstrated and easily preserved.

In some cases although the parathyroid glands have not been removed tetany occurs probably the result of temporary interference with the blood supply. A patient with either transient or permanent tetany should not be allowed to progress into the advanced stage of this complication.

Tingling of the fingers or end of the nose cramping of the fingers hands or extremities or any other strange or unusual feeling suggests immediate investigation for Chvostek's sign by tapping the facial nerve observation of the position of the hands following the application of the blood pressure cuff and the determination of blood calcium levels. If Chvostek's sign or the accoucheur's position of the hands is present following the application of the blood pressure cuff and the symptoms are acute one should not wait for the blood calcium determinations but should give calcium gluconate intravenously and calcium by mouth in daily doses of 50 to 100 grains or more.

If treatment is begun before advanced tetany with its convulsive seizures occurs the condition is not only easier to handle but the patient and his family are spared the apprehension and emotional ordeal which are associated with such a seizure. If true tetany occurs and persists fortunately it can be controlled adequately by the oral

administration of dihydrotachysterol (A T 10) in doses of 0.5 to 1 cc. a day. It can also be controlled by vitamin D concentrates in daily doses of 50,000 to 150,000 units. Calcium should be given in conjunction with either of these preparations.

CRISIS

With improvement in the preoperative preparation of the patient with severe hyperthyroidism postoperative crisis is no longer as common as formerly when more patients consulted the surgeon late in the disease and when less was known about preoperative preparation. Postoperative crisis should not occur if the patient is properly prepared with Lugol's solution, thiouracil, a high carbohydrate diet, and 1,000 cc. of 10 per cent glucose as advocated by Dr. E. C. Bartels of our staff.

Postoperative crisis is best controlled by preoperative preparation and by limiting the extent of the thyroid operation according to the patient's condition. When a patient has widening pulse pressures, requires increasing amounts of oxygen while on the operating table (600 to 1,000 cc. per minute), has lost large amounts of weight preoperatively, has long standing hyperthyroidism, and particularly when he is over 50 years of age, the operative procedure should be limited to a first stage subtotal hemithyroidectomy. A complete subtotal thyroidectomy in such a case can result in such a severe crisis that it can be controlled satisfactorily only with great difficulty.

If thyroid crisis occurs, the oxygen tent, fluids, intravenous iodine, glucose, and sedatives must be employed to overcome a condition which often could have been averted by proper preoperative preparation.

RECURRENT LARYNGEAL PARALYSIS

In discussing recurrent laryngeal paralysis I often have said that I have been impressed with the misunderstanding about the clinical evidences of this condition, particularly in the minds of surgeons who have not dealt with many cases. An understanding of the sequence of events following injury of both recurrent laryngeal nerves and the clinical results is important.

If both recurrent laryngeal nerves are paralyzed by ligature, crushing, or severance during thyroidectomy, there will be no particular difficulty with breathing, but the voice will be only a whisper. With injury to both recurrent laryngeal nerves, both the abductor and adductor muscles are paralyzed and so both cords are in a flaccid state. At the end of four to five months the patient who has been without a voice begins to acquire the ability to speak with a reasonable tone, one which increases in magnitude weekly. While the patient is really pleased with this, to surgeons who have seen as many nerve injuries as we have as a result of the referral of patients for possible repair, it is

but evidence that the cords have come together in the midline with narrowing of the glottic space. As a result, eventually the supply of oxygen will be insufficient for the patient's needs particularly during any vigorous activity.

The laxity in the cords which were previously in the cadaveric position is taken up as a result of atrophy fibrosis which readily can be seen by laryngeal examination. If at the end of several months when only one nerve has been cut the cord with good function is compared with the paralyzed one the former will be of good color and of reasonable thickness while the latter will be thin pale atrophic and fixed in the midline. This is the result of shortening of the cord from atrophy fibrosis and thinning and when both cords are paralyzed this essential shortening brings both cords into the midline and produces a voice.

The clinical course of events therefore when both recurrent laryngeal nerves are injured is (1) the patient breathes reasonably well but is unable to speak (2) after a few months he is able to speak and still breathe relatively well and (3) after a few months he is still able to speak but he is unable to breathe satisfactorily on exertion and the narrowness of the glottic space is evidenced by crowing when he endeavors to get an adequate amount of air through an inadequate glottic space.

Injury to one recurrent laryngeal nerve may result in temporary interference with the tone of the voice which usually never recovers its original range however the voice eventually becomes relatively satisfactory. If one observes the larynx some months after a unilateral recurrent laryngeal paralysis the injured cord will be fixed in the midline position with the uninjured cord approximating or extending beyond it in a compensatory manner.

The statement is frequently made that the incidence of recurrent laryngeal paralysis in operations by experienced thyroid surgeons is so low that it need cause no concern. However since no complication can be more distressing to the patient than bilateral recurrent nerve injury everything possible should be done to prevent it. For this reason I originally proposed demonstration of the recurrent laryngeal nerves in all thyroid operations. This does not completely eliminate the occasional nerve injury in operations for carcinoma of the thyroid or in technically difficult thyroidectomies for hyperthyroidism. It does however reduce the injury to recurrent laryngeal nerves to a minimum. This is evidenced by the fact that in the removal of 23 000 goiters at the Lahey Clinic there has never been a persisting bilateral recurrent laryngeal paralysis. In addition during the last eight years the incidence of recurrent laryngeal paralysis including those patients operated on for cancer of the thyroid gland has been but 0.3 per cent.

One of the questions that is repeatedly asked us is whether the severed nerve can be anastomosed with an expectation of return of

function. We have sutured recurrent laryngeal nerves in 4 patients, who had been referred to us for possible repair. The ends were found without difficulty and sutured accurately but none of the patients has had a really satisfactory end result. The reasons for this are that when recurrent laryngeal nerves are cut surgeons delay doing anything in the hope that function will be restored. They hesitate to try to find the cut ends of an injured recurrent laryngeal nerve when the wound is still edematous and in an unsatisfactory local condition. Also patients probably dislike to undergo another surgical procedure immediately after having been through a rather serious operation during which the nerve was accidentally cut.

These reasons tend to bring the patient with a cut recurrent laryngeal nerve to the surgeon some weeks or months after the original injury by which time the cord is fibrosed and the arytenoid muscles are fixed. Even though the nerve ends can be found and their conductivity restored the fixation and fibrosis of the cord are such that abduction, adduction and function are probably impossible.

If a vocal cord is demonstrated as powerless immediately after thyroidectomy one has two choices. First, one can leave it alone and if the injury is unilateral it usually causes little difficulty. Secondly one can reopen the wound, search for the nerve, follow it accurately up to the point of entrance into the larynx beneath the lowest fibers of the inferior constrictor and demonstrate whether it has been crushed, tied or cut and repair it. Resuture immediately after operation offers practically the only chance of restoration of function since the arytenoid muscles are still movable and the cords are not fibrosed.

What can be done for the patients with long standing bilateral abductor paralysis? Such patients are really in a pitiable condition. On the slightest exertion they are anoxicemic, they often have to sit down after walking upstairs and if they develop a cold they are in real danger of suffocation.

Three procedures may be offered to patients with long standing abductor paralysis: (1) tracheotomy with a flap valve which automatically closes on expiration so that the patient is able to speak; (2) the operation which has been practiced by Dr. Walter B. Hoover, head of our Department of Ear, Nose and Throat, that is submucous resection of one of the paralyzed cords thus making an adequate mucous membrane lined airway in the larynx; and (3) the operation devised by Dr. Brien King which consists of pinning back the arytenoid cartilages with an extralaryngeal stitch.

Each of these procedures has its advantages and disadvantages. We explain to the patient the advantages and disadvantages of the first two methods, that is tracheotomy and direct operation, and allow them to make a choice. Since we have had no experience with the Brien King operation we do not know whether by the extralaryngeal pinning of the arytenoid cartilages backward the cords are held open

adequately and permanently. Therefore we will withhold judgment until further follow up reports are published.

If the patient does not object to a tracheotomy tube the flap valve permits an adequate intake of air and with the closed valve a good voice.

The disadvantage of submucous resection as devised by Dr Hoover is that with removal of one cord there is a definite loss of voice. Most patients speak in a high whisper although some have a fairly good voice. The patient must be warned that he may not be able to talk over the telephone or make himself heard at some distance.

As one reviews recurrent laryngeal paralysis one realizes that the best treatment is prevention of injury by demonstration of the nerves so that they can be protected throughout the operation.

MUCUS

Following subtotal thyroidectomy for exophthalmic goiter adenoma or intrathoracic goiter a considerable quantity of tenacious mucus often is present in the trachea for a few days. Under treatment with steam inhalation this usually disappears spontaneously within three days. However in certain cases the amount of mucus within the bronchial tree is of sufficient quantity to make breathing really difficult. In such cases postoperative suction bronchoscopy often makes breathing easier and we feel certain that it has saved patients' lives. If mucus is sufficiently troublesome after subtotal thyroidectomy we recommend that an intratracheal catheter be passed to suck out the bronchial tree or if the mucus is of sufficient amount postoperative suction bronchoscopy can be instituted immediately. Contrary to what one would expect in a patient recently subjected to a thyroidectomy this has not been a trying ordeal and if indicated we have never hesitated to employ it.

WOUND COMPLICATIONS

Wound complications following surgery on the thyroid gland in our experience are not serious. Very rarely does infection occur. Accumulated collections of serum are not serious and usually disappear by the end of two to three weeks.

If there has been a small hemorrhage beneath the skin flap an accumulation of serum will make a pocket beneath the skin flap but this can be drained by a small puncture through the wound with satisfactory results. Occasionally the pocket of serum is of considerable size and fills and refills. The introduction of an indwelling baby catheter into the pocket permits it to remain open and collapse and the walls to adhere and shortens the course of the discharge of the serum.

Angulation of the skin wound as a result of drainage of an accumulation of serum or hematomas within the wound is occasionally dis-

turbing. Almost never has it been necessary for us to revise such an angulation of the incision. The patient is instructed to pull down on the scar at the end of two weeks when it is healed and within a period of four or five months a symmetrical scar usually results. We strongly advise against revision of a thyroid scar within a year.

Keloids because of their prominence are always a problem in the thyroid scars. The postoperative irradiation of keloids has not been very successful. These are best treated in our experience by excision of the keloid and then irradiation of the scar within a week in order to prevent the formation of another keloid.

Before operating upon a female patient with a delicate skin, one should inquire concerning scars on other parts of the body which can be investigated as to the possible presence of keloids and if there are such keloids roentgen ray therapy of the healing scar should be instituted within a week following the operation.

EARLY REMOVAL OF DRAINS

There is one further warning concerning the prevention of complications following thyroidectomy and this concerns the removal of drains from deep mediastinal pockets remaining after the removal of intrathoracic goiters. Assistants inexperienced with intrathoracic goiter may remove a drain from such a deep mediastinal pocket at the end of six to eight days. At this time the large pocket within the mediastinal cavity has not yet collapsed, its walls have not become adherent, and the pleura has not yet expanded. Such a patient may be sent home, only to return to the hospital with a high temperature and large amounts of fluid in the mediastinal pocket. Fortunately by this time protective walling off granulations have occurred within the mediastinum and in none of our cases has mediastinitis occurred. When a drain is put in a mediastinal cavity following the removal of intrathoracic goiter it should not be removed for at least seven or eight days and when removed a rubber or catheter drain should be inserted and gradually shortened over a period of two to three weeks until the pleura has expanded and the mediastinal cavity is completely obliterated.

SUMMARY

The following postoperative complications of thyroidectomy are discussed: hemorrhage (venous and arterial), tracheal obstruction, tetany, crisis, recurrent laryngeal paralysis, mucus wound complications and the too early removal of drains in intrathoracic goiter.

POSTOPERATIVE PROBLEMS FROM THE INTERNIST'S POINT OF VIEW

LEWIS M. HURXTHAL

The diagnosis and treatment of postoperative complications has undergone gratifying improvement in the last ten to fifteen years. This has come about through greater interest in the causes and prevention of these complications. Anesthetists particularly have made important contributions in this field. The important role played by a disturbance in the mechanics of respiration with the effect of certain anesthetic agents on the respiratory mucosa is now fully realized. The conservation of heat in the operated patient is a routine procedure. The discarding of drastic preoperative preparations particularly violent purging and starvation has helped conserve water balance and energy reserve.

An accurate and intelligent *preoperative survey* of the debilitated and seriously ill patient is now possible, thus reducing the chance of postoperative complications. Liver function tests and the estimation of prothrombin time and blood protein have proved their usefulness. The administration of sodium chloride is routinely watched lest it be overdone; on the other hand chloride or total base loss is more frequently suspected. The drain of extensive weight loss on the protein reserves of the body is more fully appreciated.

Surgeons are now being guided by the results of *laboratory analyses* in many of their postoperative problems. Blood chlorides, urea or nonprotein nitrogen, blood proteins and bilirubin estimations frequently are ordered and have proved of great value in doubtful cases. This invasion of what was once considered the medical field and the medical man's interest in surgical problems creates a progressive atmosphere for handling postoperative complications.

Oxygen is generally procurable and although often given on the slightest pretext its availability undoubtedly has carried some patients through an acute pulmonary complication. The use of oxygen in postoperative cases in which considerable respiratory interference is certain to occur often is justified as a supportive measure. Such use however does not eliminate the need for careful diagnostic procedures should difficulties arise.

The establishment of *blood banks* has been a great stride forward. Lifesaving from this development has been and will be substantial but care must be taken not to use blood or plasma in a wasteful way. In wartime waste is often unavoidable in a justifiable cause but in the civilian hospital there is no excuse for extravagance in the use of this precious material.

A more daring initiative in the approach to some postoperative complications is noticeable. Whereas in former years bronchoscopy or gastric lavage was considered risky in many cases their use or the use of nasal tubes or intravenous drip today causes little concern. Hesitancy in resorting to these procedures may be costly.

Preoperative preventive measures although more fully utilized than formerly probably have even greater possibilities. More attention is paid to the prevention of thrombotic complications and pulmonary embolus. Anticoagulants can be used particularly in patients in whom such complications occur following previous operations. Foot and leg exercises and frequent turning of patients are widely used. Preoperative saturation with sulfa drugs or their use in wounds or operative fields has been valuable. Careful consideration of all possible complications and a conscientious effort toward prevention should yield worthwhile results.

GENERAL TYPES OF POSTOPERATIVE COMPLICATIONS

For the purposes of this discussion postoperative complications may be listed as follows:

Complications related to the surgical procedure

Pulmonary complications related to interference with the mechanics of normal respiration

Complications related to anesthesia or medication

Secondary infections unrelated to infection in the organ upon which operation was performed

All other complications related or unrelated to the postoperative state or to preexisting disease

DIAGNOSIS

Each operation has its most likely complications. These depend on the condition of the organ operated on, the disease with which the patient is afflicted and his general condition. The time of appearance and manner of onset of the complication are valuable in determining its nature. In many instances a knowledge of all preoperative conditions is necessary in making a definite diagnosis. Thus the surgeon or the internist should consider carefully the history and all recorded observations of the physical examination and laboratory data. This routine even before seeing the patient is worth all the time involved whether the situation is obscure or apparently obvious. Much too can be learned by careful reading of operative notes for these too often give a clue to the diagnosis. Needless to say much can be suspected or eliminated in diagnosis by gross inspection of the patient.

Some of the simpler complications which cannot be related too often frequently are overlooked. Infection in the wound as a cause of fever and thrombophlebitis of the legs are two conditions which

are most frequently not diagnosed. Dilatation of the stomach and intestines, which may produce considerable respiratory difficulty, tachycardia and even shock, is another condition often overlooked. Rectal examination may reveal impacted feces which may cause rectal or low abdominal pain, often with diarrhea, or it may disclose a pelvic abscess. A drop in urinary output may be explained easily at times by palpating a distended bladder. More frequent use of a retention catheter following major operations, such as a Miles resection or pan-hysterectomy, is a safe and accurate method of recording urine output during the critical postoperative period.

Recording the intake and output of fluids is as important as recording the pulse and temperature. The technic of postoperative examinations and treatments should be familiar to all medical and surgical interns and residents. Among these should be mentioned the method of eliciting a positive Homans' sign for the detection of thrombophlebitis, inserting a suction tube or catheter in the trachea, with or without a laryngoscope, to aspirate mucus, and inserting a Miller-Abbott tube. Even the more frequent use of the simple probe or aspiration needle could be encouraged. The portable x-ray machine should be more freely used in connection with pulmonary or subphrenic complications.

COMPLICATIONS RELATED TO THE SURGICAL PROCEDURE

From the surgeon's point of view, the following list of complications, while not complete, include those most feared or likely to occur as the result of the technical procedure undertaken or the disease involved.

Neurosurgical

- Extradural clots from oozing of blood
- Atelectasis from mucous collection in bronchial tubes
- Corneal ulcer from sensory root avulsion

Ea. Nose and Throat

- Hemorrhage after tonsillectomy
- Otitis media in sinus operations
- Meningitis from sinus thrombosis or brain abscess
- Mediastinitis from esophagoscopy

Thyroid

- Hemorrhage
- Tracheal obstruction from edema, hemorrhage or serum accumulation or recurrent laryngeal nerve paralysis
- Thyroid storm
- Acute parathyroid tetany

Chest

- Persistent atelectasis or emphysema from lobectomy or segmental pneumoectomy
- Leakage of bronchial stump
- Hemorrhage

Breast

Serum collection

Wound infection or separation

Limitation of motion followed by adhesive subcutaneous bursitis

Stomach

Gastric dilatation

Massive or partial lung collapse

Duodenal fistula

Peritonitis

Obstruction of the efferent loop or small intestine

Wound rupture

Intestines

Pulmonary embolus

Adynamic ileus

Peritonitis

Obstruction

Mesenteric thrombosis or loss of blood supply

Wound rupture

Wound hemorrhage with Miles resection

Obstruction

Gallbladder

Diaphragmatic pleurisy

Pulmonary embolus

General Abdomen

Subphrenic abscess following infected appendix gallbladder or liver perforation

Pulmonary embolus

Vomiting with excessive loss of chlorides

Ileitis

Bladder infection

Ileocecal phlebitis

Hemorrhage

Strangulation in coarctation inguinal ring

Infarction of testis or swelling hemorrhage

Acute epididymitis

Prostate

Hemorrhage

Prostatitis

Pelvic phlebitis

Kidney

Pyelonephritis

Hydronephrosis and infection from ureteral obstruction complete or partial

Auria from intracapsular or extracapsular causes

Sympathectomy Lumbar

Pain in upper inner thigh

Pulmonary embolus

Fractured Femur

Pulmonary fat embolus

Infection

Spine

Bladder infection

Hip Joint

Gastric dilatation or intestinal distention with body cast

Thrombophlebitis of varicose veins

PULMONARY COMPLICATIONS RELATED TO INTERFERENCE WITH THE MECHANICS OF NORMAL RESPIRATION

Pulmonary complications deserve special emphasis. In the majority of patients pulmonary complications are the result of interference with the respiratory movements plus inability to evacuate bronchial secretions. These complications occur soon after operation and the possibility of pulmonary embolus is unlikely at that time. Inhalation pneumonia, bronchopneumonia and atelectasis are often indistinguishable by the roentgenologist. In most instances massive collapse of one whole lung is a different matter. Bronchoscopy should be performed in all patients with massive collapse; otherwise death may result. If bronchoscopy is not possible, a small suction tube inserted by the easily passed laryngoscope may provide great relief. This method, however, will not dislodge an inspissated plug from the lower bronchi. Postural drainage, even shortly postoperatively, can be carried out in bed if excess tracheal and bronchial secretions become alarming if suction or bronchoscopy is not available.

COMPLICATIONS RELATED TO ANESTHESIA OR MEDICATION

Medication may contribute to atelectasis and should not be continued if avoidable. Medication is not infrequently the cause of other complications; for example, the commonly used phenobarbital may cause skin rash, occasionally hemorrhagic or bullous. Other barbiturates may cause wound bleeding by depressing blood platelets. Unusual drowsiness or coma in patients with liver disease may follow the use of barbituric acid derivatives. Overdigitalization or sensitivity to digitalis given just previous to operation may produce severe vomiting. A patient who fails to come out of anesthesia always should be investigated from the point of view of drug effect, for example morphine in myxedema or an overdose of sedative given by error. When fever continues in spite of the use of sulfa drugs, the drugs themselves must be suspected as the cause. Fever also may be caused by intravenous fluids which may have been given for the same reason as sulfa drugs.

Complications from anesthesia include cardiac irregularities or ventricular fibrillation following too great concentrations of cyclopropane. Cardiac standstill has occurred presumably from vagus stimula-

tion The disastrous results from prolonged asphyxia are well known and should be avoided by adequate oxygen free airways and artificial or controlled respiration until all danger is past

SECONDARY INFECTIONS UNRELATED TO INFECTION IN THE ORGAN UPON WHICH OPERATION WAS PERFORMED

Acute tonsillitis pneumonia and genito urinary infections are probably the most frequent of this group Acute rheumatic fever scarlet fever or erysipelas may occur Gout often flares up after surgery and may be mistaken for acute arthritis or rheumatic fever Infections such as subacute bacterial endocarditis typhoid or amebic dysentery may complicate any surgical procedure and may have existed previously and produced the complication for which the surgical operation was undertaken

ALL OTHER COMPLICATIONS RELATED OR UNRELATED TO THE POST OPERATIVE STATE OR TO PREEXISTING DISEASE

When *hemiplegia* occurs during or immediately after operation, cerebral thrombosis apoplexy or embolus as a cause may be indistinguishable except in so far as a clue is obtainable on physical examination More important for diagnosis is the acute or gradual onset of unconsciousness when the usual causes of coma such as uremia or diabetic coma have been excluded Lumbar puncture should be performed immediately for a pressure reading and spinal fluid examination to rule out subdural hematoma or subarachnoid hemorrhage which can be fatal but should not be if diagnosed early Metastatic lesions to the brain may be evident Brain abscess from septicemia or other causes must be considered Headache and meningeal symptoms may be produced by irritation of spinal anesthesia Streptococcal meningitis from faulty spinal technic has been known

Of the acute complications *coronary thrombosis* or infarct is often feared but actually is a rather rare event The differential diagnosis is between pulmonary embolus with acute right heart failure and almost any condition producing cardiovascular disturbance or shock such as massive collapse acute dilatation of the stomach or paroxysmal tachycardia Often in the last condition there is an antecedent history and frequently substernal pain particularly in elderly people Gallop rhythm is almost always present in tachycardia or coronary emergencies but is strikingly absent in paroxysmal tachycardia Electrocardiographic patterns help distinguish between acute pulmonary and coronary accidents Events transpire so quickly in these emergencies that a diagnosis between pulmonary embolus and coronary infarction cannot always be made but the best evidence upon which to base a decision is the type of operation evidence of existing phlebitis and absence of previous anginal history

Postoperative *acute congestive heart failure* is also rare. This is more liable to occur in patients with known cardiac disease especially mitral stenosis with or without the sudden onset of auricular fibrillation. Mitral stenosis always is prone to produce an acute emergency through the frequency with which emboli are thrown off. Most any organ may be affected resulting in hemiplegia, mesenteric occlusion or splenic infarct as the case may be. All of them are serious and unpredictable.

Fatal *pulmonary embolus*, the dreaded complication of most abdominal surgery today is receiving the preventative attention it deserves. Many patients can be saved if warning pulmonary emboli are recognized or signs of venous thrombosis are heeded. Anticoagulant therapy is encouraging. Preventative exercises are more widely used in the relief of intestinal distention and the prevention of thrombosis.

Acute pulmonary edema and *acute bronchial asthma* often present a differential problem. In the recumbent position plasma proteins fall and thus are thought to be contributory to pulmonary edema when cardiovascular disease exists particularly in the elderly or hypertensive patient. Left ventricular failure is the usual explanation of acute pulmonary edema and the likely one which with the lowering of plasma protein in conjunction with increased pulmonary venous pressure facilitates transudation. The upright position, morphine and tourniquets applied to all extremities to retard venous return provide effective treatment. The administration of adrenalin in acute pulmonary edema seems contraindicated but may actually be of help. Its use therefore is justified when other measures fail or if the attack might be due to bronchial asthma. Intravenous fluids may precipitate acute pulmonary edema if given too rapidly especially in the aged or in patients with cardiovascular disease. The best precautions are observed if not over 1000 cc are given slowly and if the patient is in a semi-recumbent position.

Postoperative *bleeding* in jaundiced patients can be controlled adequately when liver damage is not too far advanced. In such cases vitamin K is ineffective; the prothrombin time cannot be increased and only transfusions are of help. Even then they are usually only of temporary benefit.

Dependent edema may have several causes. Sacral edema precedes leg edema while the patient is in bed. Thus attention to this area will detect trouble long before it is noticed elsewhere. Hypoproteinemia and anemia should be looked for in all cases. In addition to a high protein diet amino acid and vitamin therapy may be of help. They may be given intravenously although a reaction rarely has been known to occur. As is so well known, excess quantities of salt may be responsible for edema when much intravenous therapy is given even without reduced plasma proteins. The daily quantity of salt which can be given varies but should not exceed 10 gm. Even less than this may

produce edema in elderly hypertensive anemic or hypoproteinemic patients

The occurrence of postoperative *acute nephritis* is unlikely but various degrees of suppression of kidney function may take place and are most alarming. Heroic measures often are carried out in these cases. One may err on the side of overtreatment, since spontaneous diuresis is not infrequent. Treatment must be individualized depending upon the circumstances. Spinal anesthesia, concentrated glucose and even concentrated salt solutions, transfusions, mercurial or other diuretics may be resorted to when the situation appears desperate. As yet there is no predictable therapeutics, probably due to lack of specific knowledge concerning the causes in each case.

As mentioned before, *omitting* might result from medication and should not be overlooked. Sodium retention, uremia, intestinal obstruction and paralytic ileus must be considered as a cause.

There is a general tendency to overtreat some postoperative complications with drugs or intravenous fluids and to avoid other procedures which are more trying to the patient but of greater value. When the diagnosis is not clear, it is far better to withhold drugs than to inject respiratory, cardiac or other medications in the hope that something will help. Opiates without which surgery would be far less comfortable may be misused.

Coughing is a necessary and unpleasant reflex in postoperative cases. Too much opiate may abolish the cough reflex entirely and promote the accumulation of bronchial secretions with its train of complications on the one hand, while light doses of opiate to abolish pain which has caused the patient to avoid coughing may be of great value on the other.

Thus in some cases the problems of postoperative care require more expert judgment and ingenuity than the surgical procedure itself. This attitude toward postoperative complications should be emphasized in postgraduate surgical training. Continued cooperation between the medical and surgical consultants will reduce still further the surgical mortality.

COMPLICATIONS AFTER THE MIKULICZ TYPE OF RESECTION

RICHARD B. CATTELL

It is my purpose in this paper to present complications that have been encountered at the Iahey Clinic following the modified Mikulicz type of resection for both inflammatory and malignant lesions of the colon. Since 1930 over 350 of these resections have been performed. Some of these complications might be said to be peculiar to this type of resection. They are not frequent and since most of them can be avoided this presentation of our experiences may be of help to others.

TECHNIC

It is important to understand the principles of the technic of the modified Mikulicz operation as performed in this Clinic in order to evaluate the procedure and to understand some of the complications. Since the technic has been described elsewhere¹ only a brief statement concerning it will be included in this paper.

The lesion is freed up with an ample margin of normal bowel on each side and a wide resection including an adequate portion of the mesocolon is performed. The amount of bowel resected is determined by the position of the lesion, its apparent extension and knowledge of the areas where spread most frequently occurs. An equally radical removal can be performed in employing this Mikulicz principle as in resection and primary anastomosis.

Another important determining factor in the extent of resection is the arterial blood supply. This roughly divides the portion of the large intestine amenable to a modified Mikulicz resection into the segment of the *right colon* including the hepatic flexure supplied by the ileocolic and right colic artery, the *transverse colon* including either the hepatic flexure on the right or the splenic flexure on the left supplied by the middle colic artery, and the *descending colon and sigmoid* supplied by the left colic and sigmoidal vessels. By division of the avascular attachments it is possible to get adequate mobility to approximate the various segments of the colon without interference with the arterial blood supply of the remaining colon.

The primary differences between the modified Mikulicz operation and resection and primary anastomosis are first the former is necessarily a two stage operation and secondly intraperitoneal anastomosis which we consider the greatest hazard to colon surgery is unnecessary. Also the lesion is always removed at the first stage so that there is no possibility of further extension or of contact recurrence.

COMPLICATIONS

The complications that may follow the modified Mikulicz procedure are (1) those that may follow the first stage operation or resection (2) those that occur in the interval between the first and second stage and are likely to be related to the division of the partition between the two loops by spur crushing clamps (3) those related to the closure of the temporary intestinal fistula or colostomy and (4) the immediate and remote complications following completion of the operation.

Complications Following the First Stage Operation—In carrying out the first stage or resection a common fault that results in later difficulty is an inadequate spur that is sufficient approximation of the proximal and distal loops is not effected. Failure to make an adequate spur usually is due to insufficient mobility of the intestine and of the mesocolon. As one's experience with this procedure increases this fault rarely occurs. The two loops should be approximated by sero-muscular sutures for a sufficient distance so that no other structures can come between them. This will prevent injury to the blood vessels by the spur crushing clamp.

Obstruction may occur unless good approximation of the mesocolon is obtained. This is particularly true for splenic flexure resection in which the peritoneum of the mesocolon is very thin. I have seen death follow a rent in the mesocolon in this area. Similarly obstruction may occur unless peritonization of the denuded operative field is carried out. Loops of small intestine may prolapse or fall into the raw area, become adherent and obstructed. If the projecting loops are brought out through the lower abdomen it is our practice to close the lateral gutter as well as to peritonize the field as in a colostomy during abdominoperineal resection.

The mesocolon should be divided at a right angle to the colon to avoid endangering the blood supply. Every resection should be made with careful visualization or palpation of the important blood vessels. Following division of the mesocolon the remaining proximal and distal portions must be handled carefully to avoid detaching the vessels. Failure to establish a satisfactory blood supply at the conclusion of the resection may well result in death because of a *sloughing loop*. It is not enough merely to save the mesocolon of the segments to be preserved but the vascular supply must be a normal one and the anastomotic or marginal vessels between the main arteries must be present.

Adequate mobility is likewise necessary so that the approximated loops may emerge from the closed incision without tension. Unless this precaution is taken *retraction of the loops* may occur. This complication may be extremely serious and may result in an increased hospital stay because of infection in the incision. If retraction below the peritoneum occurs peritonitis will result just as it occurs when the blood supply is inadequate below the peritoneal level. If there is

retraction of the proximal loop with resulting discharge through some portion of the abdominal wall cellulitis or wound abscess may develop Peritonitis is an uncommon complication of the modified Mikulicz operation and usually follows resection of a perforated malignant lesion or one with an abscess If the bowel segments are intact, it has less significance than in a primary resection in which leakage has occurred along the suture line

Complications That Occur in the Interval Between the First and Second Stage—These are usually not serious and most of them are concerned with the application of the spur crushing clamp We utilize an ordinary Ochsner clamp and apply it two or three times in order to have the spur properly cut down Just as failure to create an adequate spur is the cause of the most common complication incidental to the Mikulicz operation failure to cut the spur down sufficiently will also give an unsatisfactory result

Pain and at times *nausea and vomiting* following application of the clamp are most apt to occur if the clamp encloses either appendices epiploicae or a portion of the mesentery If a double row of sutures is used to approximate the two loops making certain that no fat or other structures can come between them to be enclosed with the clamp these difficulties are avoided

In 3 of our cases a *hemorrhage* has resulted from the open colostomy following application of the clamp This complication which usually results from applying the clamp to an improper place on the spur was handled without much difficulty by putting retractors in the colostomy visualizing the bleeding point and applying a suture ligature

Only 1 of our patients has had *perforation of the bowel* from application of a clamp Surprisingly enough this occurred only recently in our experience and apparently resulted from applying a clamp where the two loops could not be easily approximated This patient made an uneventful recovery because the abdomen was opened immediately and the rent closed

In only 1 case has a *fistula* of the small intestine resulted from application of a spur crushing clamp This was a fistula of the jejunum following a difficult resection of an extensive perforated lesion of the splenic flexure Great difficulty was experienced in closing the mesocolon and apparently a loop of jejunum passed upward under the spur This patient made a good recovery following operative intervention with division of the jejunum just proximal to the fistula turning in the distal end and implanting the proximal end 6 inches distal to the fistula

In the application of the modified Mikulicz type of operation for right colon lesions *fluid loss* and the resulting complications have been fairly frequent This problem which has been most troublesome in patients with poor kidney function usually has been met successfully

by early application of the spur clamp and by fluid and salt replacement. We have observed hypoproteinemia in a number of these cases.

Another less serious complication has been some degree of *skin or wound irritation*. As soon as the spur is cut down sufficiently on the right side most of the fluid content will pass on into the distal colon.

Polyps in the colostomy frequently occur and our experience has been similar to that of others in finding that 15 to 20 per cent of patients with carcinoma have one or more mucosal or adenomatous polyps. The modified Mikulicz type of operation gives a great opportunity for the discovery and treatment of colonic polyps that would otherwise be missed. The frequent occurrence of polyps in the remaining colon portions was forcibly called to my attention a few years ago when within a few days I saw 4 patients with a polyp prolapsing from the colostomy after Mikulicz resection. Visualization of the mucosal surfaces of the proximal and distal loops of the Mikulicz colostomy by the regular proctoscope and removal by application of a ligature at the base of the normal mucosa are a simple matter. All other polyps can be fulgurated lessening the danger of subsequent malignancy in the colon of that patient.

A striking instance of the efficacy of such treatment occurred in a man with a carcinoma of the descending colon 4 inches distal to the splenic flexure. No other lesion could be seen after barium enema. Routine proctoscopic examination revealed four polyps in the lower 8 inches of the rectosigmoid and rectum. A modified Mikulicz resection was performed removing the distal transverse colon, splenic flexure and descending colon and joining the transverse colon to the sigmoid flexure. The resected malignant specimen contained seven polyps. Twenty-four additional polyps were fulgurated through the proctoscope inserting it in the proximal and distal loops of the Mikulicz colostomy and the four lower polyps were also destroyed. This man has remained well for five years and was saved from total colectomy.

Complications Following Closure of the Colostomy—Complications following the second stage of a modified Mikulicz operation are largely avoided if a sufficient interval elapses between the first and second stage. The colostomy should be closed on a second admission six to eight weeks following discharge from the hospital. This permits subsidence of inflammation incidental to the operative incision and application of the spur clamp and the tissues become soft and pliable. Any existing low grade infection too usually will subside during this interval. Proctoscopic examination of the colostomy can be performed and in order to avoid further difficulty one should always determine that the spur has been properly cut down. We have experienced little difficulty in obtaining satisfactory extraperitoneal closure with rapid healing of the wound after the first stage. It has been unnecessary to resort to the method recently described by Pemberton in which the

bowel closure is followed by packing and subsequent secondary closure of the wound. Fecal discharge following closure is unusual and is due to an inadequately cut down spur failure to obtain complete inversion of the mucosa or encroachment on the lumen by turning in too much bowel. Unless definite obstruction is present any drainage usually ceases within a few days. Peritonitis is avoided by the extraperitoneal closure.

Infection in this closure wound is rarely of clinical importance. Even though closure is performed in the presence of a wound contaminated by the open colon, healing is usually prompt with only a small amount of serous or purulent discharge.

Melena sometimes occurs but is of little importance. Occult blood in the stools disappears promptly. Only 1 patient who had a Mikulicz closure involving the ileum had a hemorrhage following closure. Bleeding occurred during the first six hours after operation and blood transfusion was necessary. The wound was opened, the sutures closing the bowel were removed, the bleeding point was found and a second closure was performed.

Immediate and Late Postoperative Complications—Many of the immediate and late postoperative complications such as occur following any serious abdominal procedure are related to the fact that a high operability rate is maintained. During the last six years over 80 per cent of all patients with large intestinal lesions have been submitted to resection. This includes elderly patients, many poor risk patients including the obese, those with serious cardiac conditions and those with poor kidney function.

The mortality at the Lahey Clinic following the modified Mikulicz operation, even in applying it in a large number of unfavorable cases, still remains between 10 and 12 per cent. Few deaths are the result of peritoneal infection, most of them being due to coronary thrombosis, pulmonary embolism and uremia.

If large segments of bowel have been removed, *frequent stools or diarrhea* may be a complication for a time. Two stools a day for the remainder of life is not uncommon. Rarely is constipation present in a patient who has had a colon resection.

A few of our patients have developed *large abdominal tumors* at the site of resection. One of these patients who was thought to have a recurrence was found on operation to have a large fecal impaction. It is difficult to differentiate between recurrence at the resection site and a fecal impaction by roentgenologic examination. This complication can be avoided by removal of the redundant and excess portion of bowel at the time of closure. One tends to err on the side of leaving an ample amount rather than risk encroaching on the lumen at that point.

Early or late *recurrence* following the modified Mikulicz type of resection has occurred in 45 per cent of our patients who have survived resection. This includes those in whom a palliative resection was

done. Of those followed from five to ten years 55 per cent had no recurrence during the period of observation. The possibility of contact occurrence has been eliminated entirely by removal of the lesion at the first stage.

SUMMARY

Some of the complications following the modified Mikulicz type of resection as employed at the Lahey Clinic have been enumerated and discussed. Means for their prevention are emphasized. The modified Mikulicz resection is the same in extent as that of primary resection with anastomosis but different from it in that it is a two stage operation and is performed without intraperitoneal anastomosis. The use of this operation in over 350 patients has given satisfactory results.

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THE PREVENTION AND MANAGEMENT OF POSTOPERATIVE PULMONARY COMPLICATIONS

Report of Five Cases

URBAN H. EVERSOLE

COMPLICATIONS involving the respiratory system are quite frequent following surgery. Many of these are of minor importance. However, all too frequently they result in an increase in postoperative morbidity and even mortality. The importance of this subject to everyone concerned with the preoperative, operative or postoperative care of surgical patients cannot be overemphasized.

While this paper could include all types of pathologic conditions which might occur in the chest following an operation, such rarer conditions as pneumothorax, bronchopleural fistula, empyema and mediastinitis will not be considered. This discussion will be limited to those conditions that are known under such names as *postoperative* or *postanesthetic pneumonia*, *pneumonitis* and *atelectasis*. One still frequently hears the expression by a layman and sometimes by a physician too, that the patient died from "ether pneumonia" or that everything was fine until pneumonia developed.

PATHOGENESIS

Our thinking on this subject has passed through somewhat of a cycle. In the past when almost all anesthesia was ether, any respiratory difficulty after operation was called "ether pneumonia." With a revival of interest in spinal and regional anesthesia, the natural reaction was to assume that since nothing was being introduced into the respiratory system, these troublesome complications would disappear. Unfortunately, this did not occur. Many observers have reported that the method of administration of the anesthetic made little difference in the incidence of postoperative pulmonary complications.^{1, 5, 8} This naturally led to the assumption by many that anesthesia has little if anything to do with these complications, and regardless of what happened to the respiratory system postoperatively, the anesthetic agent and method, as well as the anesthetist, were absolved of all responsibility. The theory that these postoperative respiratory complications can be explained on the basis of a localized bronchial edema of neurogenic origin or localized bronchial constriction^{10, 11} can be dismissed without comment, since these two factors probably rarely, if ever, play any part whatsoever.

Another theory that has been advanced to explain the occurrence of postoperative complications involving the respiratory system de-

serves a little more consideration. It is thought by some that at least some of the postoperative respiratory morbidity so frequently characterized by clinical and roentgenologic signs of collapse of varying amounts of lung tissue can be explained on the basis of reflex constriction and secretion of the bronchial or bronchiolar mucosa secondary to emboli in a pulmonary artery or its branches. De Takats and his coworkers⁴ have cited experimental evidence in support of this theory. As pointed out by Waters¹³ this theory offers little encouragement that prevention can be accomplished other than through improvement in surgical technique and circulatory stimulation. Furthermore the clinical course of most of these patients particularly their response to tracheal and bronchial aspiration would lead one to discount this explanation except in the occasional case.

The most widely accepted and plausible theory and certainly the one most in accord with the usual clinical course of these patients, is that most pulmonary difficulties occurring after surgery are due to mechanical obstruction of portions of the tracheobronchial tree by secretions. Usually these secretions would not be considered abnormal, and are as a rule present prior to surgery. That bronchial secretion with obstruction and absorption of air distally could be responsible for collapse of lung tissue was recognized by Gairdner^{8, 7} as early as 1850. In more recent years many observers have recognized the importance of accumulated secretion in the tracheobronchial tree as the primary cause of pulmonary atelectasis.^{1, 3, 6, 11, 12} How these secretions in the respiratory passages which prior to surgery did not constitute a pathologic entity can play such an important part in postoperative morbidity calls for more detailed consideration.

A certain amount of secretion is always present in the trachea and bronchi. This is normal, serves to keep the mucous membranes soft and assists in the trapping and removal of dust particles in the atmosphere. Any degree of bronchitis, whether of infectious or chemical origin, will cause an increase in these secretions. Examples of chemical irritation causing increased secretion are the smoker's cough and the irritation caused by an anesthetic agent such as ether.

Ordinarily ciliary activity plus an occasional clearing of the throat and a cough or two on rising in the morning will take care of the secretions in the trachea and bronchi. Perhaps the greatest single stimulus to the raising of accumulated secretions in the normal ambulatory person is the change from the reclining to the erect position in the morning.

PREDISPOSING FACTORS

Many factors associated with the preparation of a patient for surgery, the conduct of the anesthetic and operation, and postoperative care may upset the normal physiologic removal of these secretions. In the first place he does not rise from the horizontal to the per-

pendicular *position on the morning of operation* This would seem a reasonable routine to institute particularly in patients who have a history of a chronic cough considerable expectoration or are heavy smokers Furthermore he may have received a *sedative* the night before operation to insure a good night's sleep Certainly on the morning of operation he will receive drugs which tend to raise the threshold of the cough reflex These drugs may also tend to decrease respiratory exchange and even to depress respiratory activity sufficiently to result in inadequate expansion of large areas of the lungs

In the operating room other things may contribute further to the accumulation of secretions in the air passages and to inadequate expansion of the lungs or even inadequate oxygenation of the tissues If a *general anesthetic* is administered chemical irritation of the mucous membranes or inadequate oxygenation due to unrelieved partial respiratory obstruction may result If the anesthesia is deep respiration will be depressed perhaps to a point where the minute volume exchange is insufficient to provide adequate oxygen If the anesthetic agent is one that produces a prolonged period of respiratory depression and relaxation which may last into the postoperative period the hazard of suboxygenation due to depression or obstruction is still greater Tribromethanol or avertin is an example of this type of anesthetic agent Persons responsible for the postoperative care of patients receiving such agents should fully appreciate these hazards Further more deep general anesthesia will complete the arrest of all ciliary motion and cough reflex not already arrested by the preliminary medication

If a *spinal anesthetic* is used particularly if the anesthesia is high in the thoracic segments of the cord there is a decrease in respiratory excursion This is due to the loss of intercostal muscular activity When upper abdominal surgery is performed under spinal anesthesia there is always some impairment of intercostal activity

The *position of the patient during operation* may contribute to the development of postoperative pulmonary complications¹¹ The most common position that of dorsal recumbent and level does not allow for much drainage of secretion Lemon⁹ has pointed out that secretions in the mouth were aspirated through the trachea and bronchi in dogs under general anesthesia This could be eliminated if the dog was placed in the Trendelenburg position It should be mentioned however that the Trendelenburg position particularly in obese patients tends to throw the weight of the viscera against the diaphragm and may contribute to compression of the lung bases If the patient is placed on the side with the table broken and any kind of lift is placed under the flank as is so common for operations in the chest on the kidney or on the sympathetic trunk this tends to compress the dependent lung and to allow drainage of secretions into the dependent bronchus As evidence of this is the common observation that post

operative atelectasis in these cases is much more likely to occur on the opposite side from the operation (Figs 201 and 202)

The mere fact that the abdomen is open has long been known to result in some elevation of the diaphragm with consequent compres

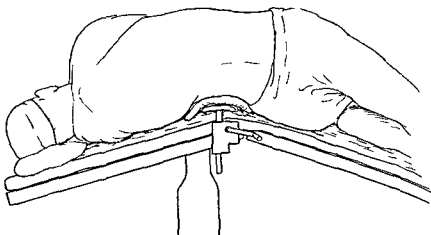


Fig 201—Diagram showing compression of thoracic cage and displacement of patient in kidney position

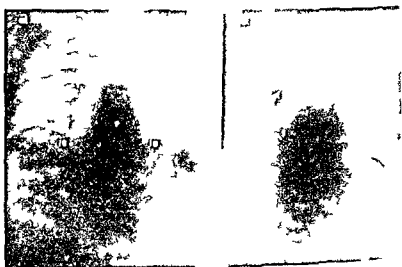


Fig 202—Radiogram of model used in Figure 201 a Dorsal recumbent position b Kidney position Note decrease in elevation of dependent l

tion of the lung bases Retractors and packs in the upper abdomen may contribute further to this compression¹¹

During the postoperative period many factors may contribute to the accumulation of secretions in the tracheobronchial tree and in adequate lung expansion Some *pneumonia* is almost the inevitable result of

surgery. If the surgery was in the abdomen the presence of pain from the standpoint of pulmonary complications takes on a special significance. Coughing, moving and deep breathing, all of which are important in the removal of bronchial secretions, cause pain. Hence the patient will tend to refrain from all these activities.

Tight binders are often placed on the patient following abdominal surgery. If these are high enough to restrict respiratory movements they may contribute to the development of pulmonary complications.

Medications for the relief of postoperative pain may cause respiratory depression and suppression of the cough reflex. The practice so often resorted to by nurses with p.r.n. orders for morphine or giving opiates to produce sleep cannot be too severely condemned. The opiates are splendid for pain relief, but there are other drugs that are much better soporifics.

PATHOLOGY

With this background of the predisposing factors to postoperative respiratory morbidity, we now can consider the pathologic conditions which may result from accumulations of secretions in the tracheobronchial tree.

When a bronchus or bronchiole becomes occluded by secretion, the air distal to the occlusion is absorbed, resulting in collapse of that

LOBULAR COLLAPSE	LOBAR COLLAPSE	MASSIVE COLLAPSE
(PATCHY ATELECTASIS)	(ATELECTASIS ONE LOBE)	(ATELECTASIS ONE LUNG)

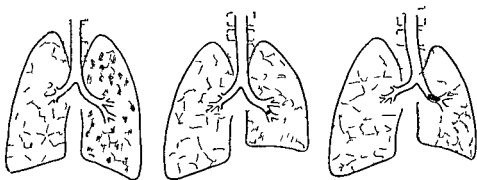


Fig 203—Diagrams showing varying portions of lung collapsed due to different positions of obstructing plug.

portion of the lung. The amount of lung involved is dependent on the size of the bronchus or bronchiole occluded. If, as is frequently the case, there is an occlusion of scattered small bronchioles, there will be scattered patchy areas of atelectasis. They are usually distributed near the base of one lung but may be bilateral. This condition commonly is known as *lobular atelectasis*. The roentgenographic findings at this stage show scattered cloudiness, not unlike the picture presented by a true bronchopneumonia. If unrelieved, it may progress

to *lobar atelectasis* in which one of the main branches of the primary bronchus is occluded or even to massive atelectasis in which an entire lung is collapsed following occlusion of a primary bronchus (Fig 203). The two latter conditions may of course arise without a preliminary lobular atelectasis. On the other hand lobular atelectasis may progress to true bronchopneumonia.

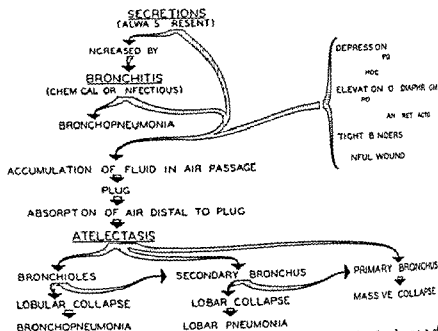


Fig 204—Diagram showing probable course of events in the development of bronchial or bronchiolar obstruction with subsequent atelectasis.

If any considerable area of lung tissue collapses and the condition is not relieved within a relatively short time *pneumonia* must be considered as almost inevitable. Certainly many factors are present that should be ideal for its development, namely, moisture, heat, and organisms in an inactive area whose resistance has been lowered by suboxygenation (Fig 204).

DIAGNOSIS

The diagnosis of pulmonary atelectasis is frequently easy, but occasionally it is quite difficult to distinguish from pulmonary embolus. Characteristically the condition develops within the first seventy-two hours following operation, frequently in the first twenty-four hours. It rarely occurs after the fifth day, although in 1 of our cases it occurred on the eleventh day and in 1 on the fourteenth day.

The patient usually complains of dyspnea and difficulty in breathing. Pain in the chest may be present, although this is not common. There is usually a rapid rise in temperature to 101° to 104° F within

an hour or two. Objective signs of suboxygenation such as cyanosis at the finger nail bases are present. Physical examination in addition to cyanosis typically reveals diminished to absent breath sounds on the affected side with a shift of the apex of the heart to this side.

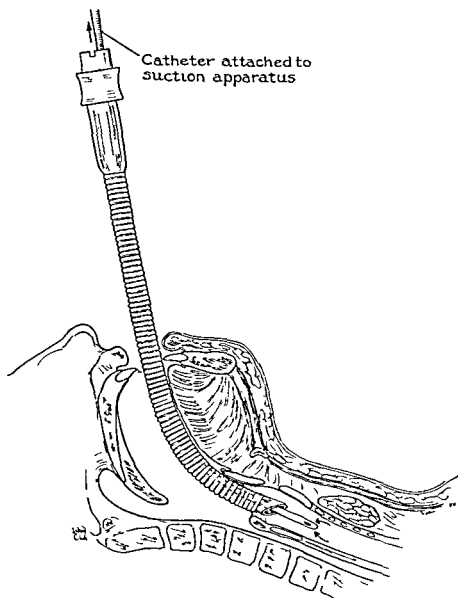


Fig 705—Diagram showing method of removing endotracheal tube. A suction catheter protrudes about 1 inch from its end. This serves to remove the last bit of secretion which may have accumulated during the course of the anesthesia.

With lobar and massive atelectasis there is frequently a lag on the affected side of the chest on inspiration or even a retraction of the interspaces. After removal of the obstruction and prior to reexpansion of the lung bronchial breathing can be heard over the affected area. The diagnosis is confirmed by roentgenogram. An important

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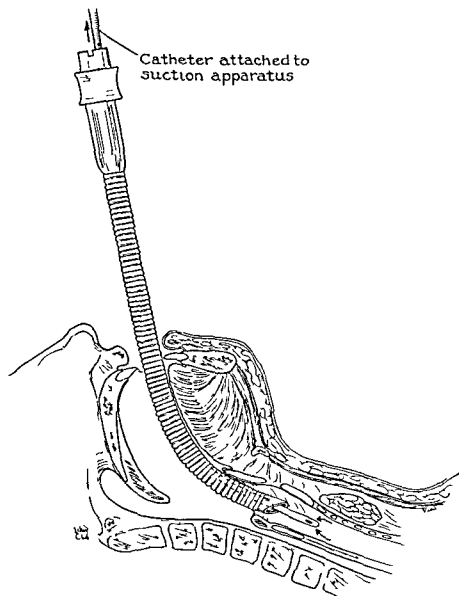


Fig. 205—Diagram showing method of removing endotracheal tube. A suction catheter protrudes about 1 inch from its end. This serves to remove the last bit of secretion which may have accumulated during the course of the anesthesia.

With lobar and massive atelectasis there is frequently a lag on the affected side of the chest on inspiration or even a retraction of the interspaces. After removal of the obstruction and prior to reexpansion of the lung, bronchial breathing can be heard over the affected area. The diagnosis is confirmed by roentgenogram. An important

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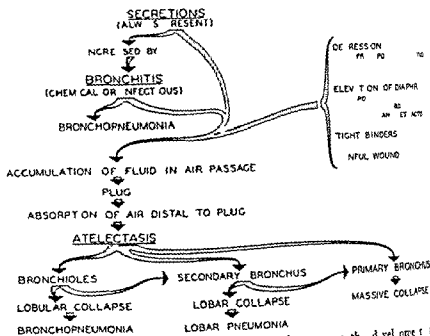


Fig 204—Diagram showing pathologic course of atelectasis with subsequent atelectasis.

If any considerable area of lung tissue collapses and the condition is not relieved within a relatively short time pneumonia must be considered as almost inevitable. Certainly many factors are present that should be ideal for its development, namely moisture, heat, and organisms in an inactive area whose resistance has been lowered by sub-
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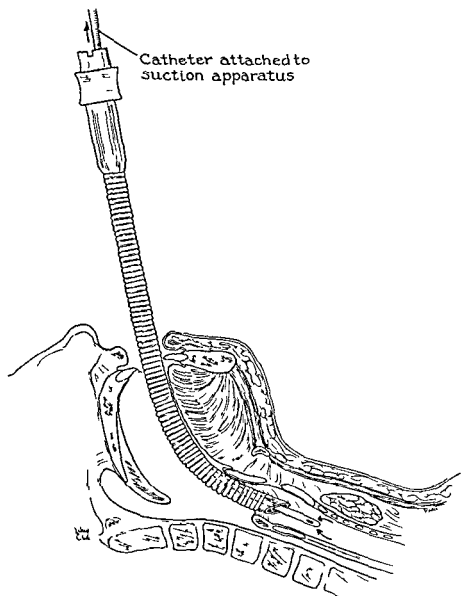


Fig 205—Diagram showing method of removing endotracheal tube. A suction catheter protrudes about 1 inch from its end. This serves to remove the last bit of secretion which may have accumulated during the course of the anesthesia.

With lobar and massive atelectasis there is frequently a lag on the affected side of the chest on inspiration or even a retraction of the interspaces. After removal of the obstruction and prior to reexpansion of the lung, bronchial breathing can be heard over the affected area. The diagnosis is confirmed by roentgenogram. An important

point to remember is that the severity of the symptoms is often greatly out of proportion to the amount of lung involved. It is our belief that any pulmonary difficulty within the first three days post-operatively should almost a priori be considered to be atelectasis. Certainly it is up to the person who disagrees to prove his point.

PREVENTIVE MEASURES

With an appreciation of the factors causing respiratory complications following surgery, a great deal can be done toward their prevention. As mentioned previously, an effort should be made to clear as much secretion out of the pharynx and trachea prior to operation as is possible. When feasible, anesthetic agents which may result in long periods of postoperative depression should be avoided. Every effort should be made by the anesthetist to maintain adequate pulmonary exchange while the patient is in the operating room. Furthermore, he should maintain a free and unobstructed airway at all times. The pharynx and trachea should be kept free of secretions during the anesthesia, and they should be thoroughly aspirated from these areas immediately prior to the return of the patient to his room (Fig. 205). Binders which restrict respiratory activity should not be used. Postoperative narcotics should be used judiciously, so as not to interfere with respiratory activity or raise the threshold of the cough reflex.

The patient should be watched carefully during the early post-operative period to prevent the aspiration into the trachea of accumulated secretions or vomitus. Later he should be turned frequently in bed and urged to cough. Nurses should be instructed how to hold the patient's abdomen to lessen the pain of coughing.

TREATMENT

We turn now to the patient who develops respiratory difficulty postoperatively in spite of all the preventative measures. If there is evidence of secretion accumulating in the tracheobronchial tree that the patient is either unable or unwilling to raise, aspiration should be undertaken. Usually a urethral catheter (size 20 to 22) in the trachea is sufficient. This can be passed either through the nose or mouth. If the catheter does not drop directly into the trachea, it can be guided in with curved forceps or a Kelly clamp through a laryngoscope (Fig. 206). If the throat is carefully sprayed with a 10 per cent solution of cocaine, this procedure will cause much less discomfort to the patient. It is usually better not to spray much cocaine into the trachea, as the spasm of coughing and straining initiated by the catheter in the trachea is beneficial in forcing the fluid out of the smaller passages to where it can be removed. Frequently this catheter is sufficient to relieve a lobar or even a massive atelectasis. However, if there is a definite collapse of one or more lobes of the lung, we be-

lieve that this aspiration should be carried through a bronchoscope as this is a much more accurate procedure. It has been said that such a patient will not stand bronchoscopy or that he will rupture the

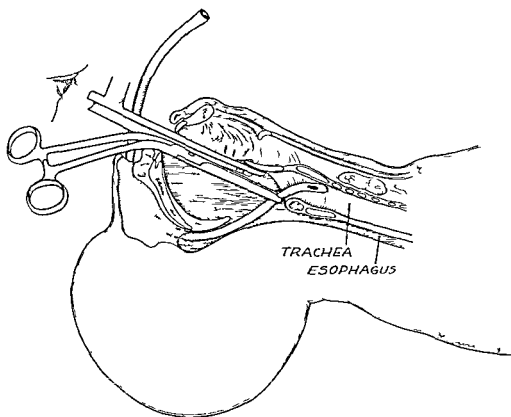


Fig 206—Diagram showing method of guiding aspirating catheter into the trachea under direct vision

wound if one is performed. Neither of these statements is true. If a strong binder is put on tight while the procedure is being carried out the danger of wound rupture is minimized.

REPORT OF CASES

The following case histories illustrate the findings and results of treatment in patients who developed respiratory complications following surgery.

CASE I—A man aged 78 years was admitted to the Clinic on December 1, 1943, complaining of high blood pressure. A roentgenogram of the chest was normal except for slight pleural thickening at the right base. A left splanchnicectomy was performed on January 12, 1944, under pontocaine spinal anesthesia. The convalescence was uneventful.

On January 21, nine days after this procedure, a right splanchnicectomy was performed also under pontocaine spinal anesthesia. On the fifth postoperative day the patient told the nurse that he had some discomfort in the left side of the

was retraction of the interspaces on the left with inspiration and shift of the apex beat to the left accompanied by total absence of breath sounds on this side. Roentgenograms revealed homogeneous density of almost the entire left lung.



Fig 209—Roentgenograms (Case II) showing *a* collapse of lower lobe of left lung *b* reexpansion of lobe following bronchoscopic aspiration

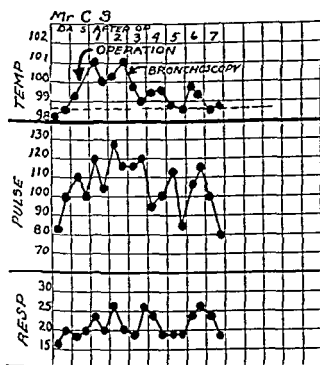


Fig 210—Clinical chart (Case II) showing fall in temperature following bronchoscopy

The right lung was clear and the mediastinum was shifted to the left. Aspiration was carried out by means of a catheter. A roentgenogram taken fifteen minutes after this procedure showed definite improvement with considerable

clearing of the left lung field and a partial return of the mediastinum to the midline. Convalescence following aspiration was uneventful.

Note that this collapse was on the opposite side from the operation and also that there was not the typical temperature elevation. This is an example of massive collapse (Figs 207 and 208).

CASE II—A man aged 52 years gave a history of bronchial asthma with an absence of symptoms for one year. The patient was operated on for acute cholecystitis with cholelithiasis under pontocaine spinal anesthesia supplemented with cyclopropane and nitrous oxide. On the second postoperative day the temperature rose to 104 F, pulse rate to 124 and respirations to 28. There was slight dyspnea and wheezing. At first there was no evidence of cyanosis but a few hours later there was considerable dyspnea and slight cyanosis. The heart sounds were shifted to the left and there was less palpation of the left chest than the right. There was considerable dullness at the left base and greatly diminished breath sounds. A roentgenogram confirmed the diagnosis of collapse of the base of the left lung. Bronchoscopy was followed by immediate and definite improvement. Clinically, reexpansion of the left lower lobe was confirmed roentgenologically.

This represents an instance of lobar collapse (Figs 209 and 210).

CASE III—A boy aged 11 years had a right lumbar sympathectomy on February 2, 1944, the first in a series of operations designed to improve a co-

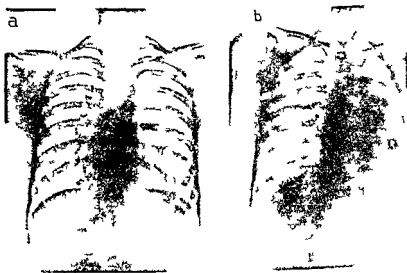


Fig. 211—Roentgenograms (Case III) taken one day before and two days after operation at time of onset of respiratory difficulty. Note density of left middle lung field with slight shift of mediastinum to the left.

genital deformity of the right foot. A roentgenogram prior to operation was suggestive of asthmatic bronchitis. The operation was performed under pontocaine spinal anesthesia. Two days postoperatively the patient suddenly developed rapid

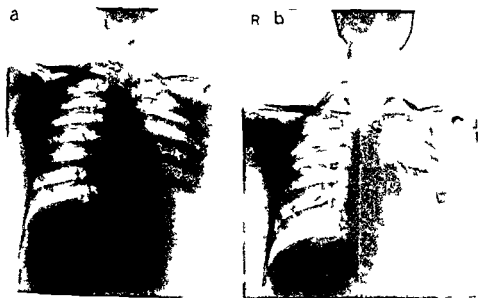


Fig 212—Roentgenograms (Case III) taken *a* immediately after tracheal aspiration *b* the following morning. Note continued clearance of left lung field with further return of the mediastinum to the midline.

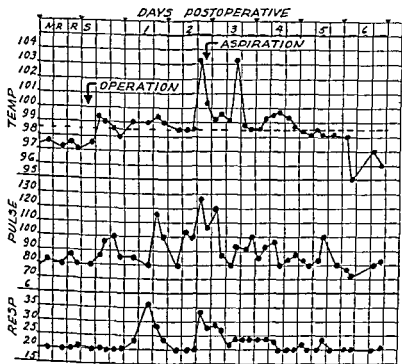


Fig 213—Clinical chart (Case III) showing immediate fall in temperature pulse and respiration following tracheal aspiration. The second temperature elevation is unexplained but may have represented another atelectatic episode which cleared without aspiration.

respiration (up to 35), a pulse rate of 128 and a temperature of 103.2 F. A dry cough was present and the left chest did not expand as well as the right on inspiration. The breath sounds were also diminished over the left chest. A roent-

genogram showed density of the mediastinum of the left lung with some peripheral density at the apex and base. The mediastinum was shifted to the left. The right lung was clear. Secretions were aspirated from the patient's trachea by means of a catheter and a roentgenogram taken immediately following showed

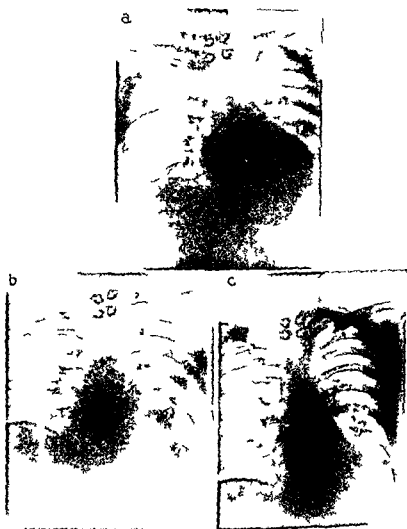
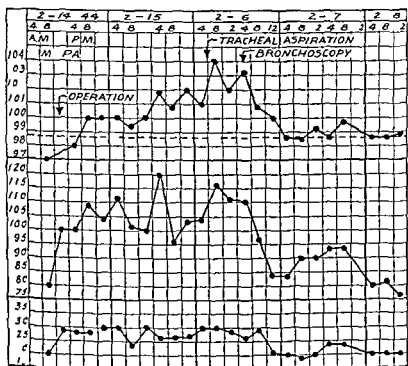


Fig 214—Roentgenograms (Case IV) taken a one hour after tracheal aspiration with a catheter shows density at left base b immediately following bronchoscopic aspiration shows some clearing at left base c the following morning shows still further clearing

about 50 per cent clearing of the left lung field with partial return of the mediastinum. A roentgenogram made the following evening showed still further clearing although some mottling still remained. The mediastinum had moved back still further toward the midline. The patient had an uneventful convalescence.

This probably represents a lobular atelectasis and the coughing and straining incidental to the aspiration were sufficient to clear the air passages so that reexpansion could follow. Note also that this collapse was on the opposite side from the operation (Figs 211, 212 and 213).

CASE IV—A man aged 21 years was admitted to the hospital with a diagnosis of primary hyperthyroidism. The basal metabolic rate was +68 per cent on admission and had fallen to +40 when operation was performed. On February 14, 1944, a subtotal thyroidectomy was performed under basal narcosis of tribromoethanol followed by an ethylene ether sequence with an endotracheal tube in



the temperature had risen to 104° F still showed considerable collapse in the area of the left base

It was decided that a bronchoscopy should be performed since the temperature had continued to rise and there was still evidence of collapse after tracheal aspiration. Following bronchoscopy the patient



Fig 216—Roentgenograms (Case V) taken *a* the afternoon of the second postoperative day *b* the afternoon of the third postoperative day. Note some density at left base. Arrows at right base indicate area of density interpreted to be slight collapse of right base. Mediastinum is not shifted to left *c* Three hours before death

showed immediate and definite improvement and a roentgenogram made immediately after the bronchoscopic procedure showed slight clearing and one taken the following morning gave evidence of still further clearing of the left lung field. Convalescence was entirely uneventful (Figs 214 and 215).

CASE V—A man aged 57 years who was rather obese with a small umbilical hernia was operated on January 18 1944 for chronic cholecystitis with cholelithiasis. The anesthetic was pontocaine spinal with a supplement of cyclopropane. On the morning of the second postoperative day the patient was perspiring profusely and coughing but was not raising any mucus. Two hours later he was raising a bloody frothy mucus and coughing continuously. He refused to lie on the right side because this increased the coughing. Five hours later he was still expectorating large amounts of bloody frothy mucus and had difficulty in breathing when lying on either his back or the right side.

A diagnosis of pulmonary infarct was made even though the patient had not complained of any pain in the chest. Since we felt very definitely that this was a pulmonary infarct due to an embolus in the pulmonary artery bronchoscopy was

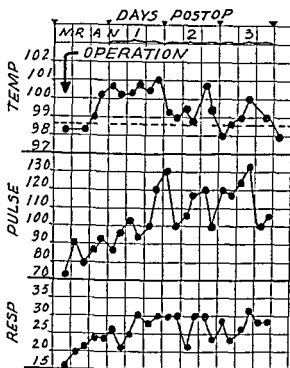


Fig 217—Clinical chart (Case V)

not performed. On the following day the patient was obviously very ill with an increase in all symptoms. He was rational and apparently quite well oxygenated when in an oxygen tent. However if he was removed from the tent he quickly became irrational and quite cyanotic. A series of roentgenograms showed evidence of a pathologic condition in the left lung base. Clinically the breath sounds were diminished over this area. There was no shift of the mediastinum although at times some retraction of the left upper interspaces was noted (Figs 216 and 217). He continued to go downhill and died on the following day.

Autopsy revealed a complete collapse of the left lung with some collapse of the right base. A very firm tenacious plug of mucus filled the entire left main stem bronchus and its branches. This plug could be lifted out with forceps. The accompanying photograph and diagram illustrate the location of this plug (Figs 18 and 219).

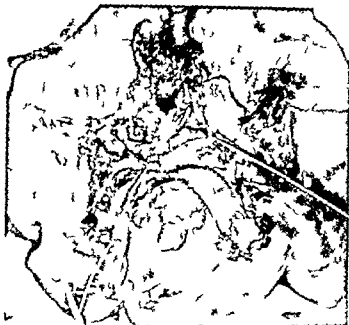


Fig. 18—Photograph of autopsy specimen (Case V) taken from posterior side of lung. The posterior wall of the trachea (*t*) and bronchi have been removed. A little plug (*e*) has been cut free and turned downward. Probes (*a* and *b*) are holding up the firm tracheal plug (*p*) which filled the entire left bronchus and trachea.

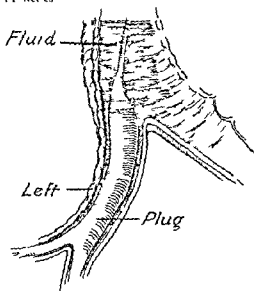


Fig. 219—Drawing made at time of autopsy (Case V). Note position of plug fading out to fluid in trachea.

This represents an unfortunate experience which again focused our attention on the need for greater diligence in watching for early signs

of respiratory difficulty postoperatively and for clear and logical thinking with reference to them. In reconstructing the course of events in this case we feel that probably there was a gradual progression from an early lobular atelectasis to a lobar and finally a massive atelectasis. This death could probably have been prevented if we had recognized that the progression of symptoms was due to an enlargement of a mucus plug rather than the enlargement of an embolus in the pulmonary artery.

CONCLUSIONS

The greater our experience with these patients the more firmly we are convinced that the term postanesthetic pneumonia is not such a bad one after all. Perhaps a better term would be postsurgical pneumonia since the anesthesia represents only one of the many factors that may play a part in the development of these complications. With greater diligence in trying to eliminate the factors which predispose to the development of pulmonary complications and more prompt and vigorous methods of treatment much postoperative pulmonary morbidity can be avoided or can be limited to postoperative atelectasis and the condition reversed before a true pneumonia develops.

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ANTICOAGULATION THERAPY OF POSTOPERATIVE VENOUS THROMBOSIS AND PULMONARY EMBOLISM

JAMES A. EVANS

At the Lahey Clinic since August 19 1941 cases of potential pulmonary embolism have been classified into three groups. In order of greatest danger to the life of the patient they are (1) Phlebothrombosis with warning benign pulmonary embolism (2) phlebothrombosis or thrombophlebitis without warning pulmonary embolism and (3) a past history of thrombophlebitis or phlebothrombosis with or without embolism spontaneous or following previous operations or childbirth.

Fifty five patients who fell into these categories have been treated by the new anticoagulative drug *dicumarol*^{1 3} with or without preliminary heparin. None of these patients had venous ligation. In 1 case a subsequent benign pulmonary embolism occurred while the patient was under the effects of dicumarol. In 1 case a fatal pulmonary embolism occurred after treatment had been discontinued a transfusion had been given and the dicumarol effect of prothrombin reduction presumably had been lost.

Only 1 patient developed a new focus of thrombophlebitis once treatment was well established and this occurred when because of inadequate laboratory observation the prothrombin time had been allowed to rise to 85 per cent. Since about 75 per cent of patients with fatal pulmonary emboli are over 50 years of age and since almost 30 per cent of that group of patients who had already had one benign pulmonary embolism is apt to have a subsequent fatal embolism venous ligation occasionally is resorted to in such patients. Six such ligations have been performed during the same thirty months. Quite often however in patients with a warning benign embolism there has been no indication that any venous thrombosis existed in either leg. If a recognizable focus of phlebothrombosis or thrombophlebitis exists in one leg an unrecognizable focus of phlebothrombosis is apt to exist in the other leg and bilateral ligation should be performed.

With growing confidence in adequately controlled anticoagulation therapy which is inexpensive and easily administered through dicumarol we are resorting less and less to venous ligation. However only sustained success in the prevention of pulmonary embolism in a larger series of cases will lead us to abandon utterly all consideration of venous division and ligation in those patients over 50 years of age who already have had one benign pulmonary embolism.

The following *disadvantages of venous ligation* must be weighed

- 1 An additional operative procedure on a patient who may be very sick
- 2 The added risk of a swollen leg at least until collateral venous circulation is accomplished
- 3 No opportunity to establish recanalization
- 4 The difficulty of knowing from which leg the embolism has metastasized and therefore to be consistent the necessity of ligating both sides unless a venogram indisputably has established a normal deep venous circulation in the supposedly healthy extremity. Venograms have their limitations in this respect
 - 5 The possibility that embolism has sprung from pelvic or abdominal veins whether or not both legs are normal
 - 6 The possibility that thrombosis may proceed above the level of ligation
 - 7 The necessity and technical difficulty of tying the common iliac vein to get above the thrombus

No article on dicumarol therapy is complete without warning against its dangers. We had early in this series 8 patients with hemorrhage 2 of which proved fatal. Water soluble vitamin K in huge doses up to 40 to 60 mg intramuscularly may prove to be an antidote.⁴ In 1 patient in whom we had an opportunity to correct a prothrombin percentage reduced to 21 per cent by dicumarol the prothrombin rose within two hours to 51 per cent in six hours to 45 per cent, in sixteen hours to 61 per cent in eighteen hours to 72 per cent, and reached 98 per cent by forty hours after 60 mg of a water-soluble preparation of vitamin K. Synkavite* had been given in one intramuscular injection.

TECHNIC

Immediately after discovery of a thrombotic emergency a base line coagulation time and prothrombin time are taken. If there is no evidence of liver trouble hemorrhagic diathesis severe renal insufficiency or postoperative hemorrhage heparin and dicumarol are started at the same time. If there is any reason to think that the prothrombin time may be reduced such as in severe liver disease the dicumarol is withheld until the prothrombin result is determined.

Heparin may be given by continuous intravenous drip or by intravenous injection every four hours. The choice depends on the condition of the patient's veins and whether he will stand constant drip administration psychologically.

If the constant drip method is preferred 2 cc of heparin in 100 or 200 cc of saline is given immediately. The remaining 8 cc in the 10 cc vial is then started at the rate of about 25 drops per minute the heparin being given in 1 000 cc saline or 1 000 cc 5 per cent glucose alternating every twelve hours. The coagulation time should be kept between

Synkavite generously supplied by Hoffmann La Roche Inc Nutley New Jersey

20 and 40 minutes. If the coagulation time exceeds 40 minutes either the amount of heparin in 1 000 cc. can be reduced or the rate of flow can be prolonged. If the coagulation time is below 20 minutes the amount of heparin in 1 000 cc. glucose or saline is increased to 9 or 10 cc. every twelve hours. I have seen patients who are heparin resistant and have needed as much as 30 cc. of heparin every twelve hours.

If the intermittent administration is desired 2 cc. of heparin is given in 50 cc. of saline intravenously every four hours day and night. While the heparin is being given the coagulation time is determined every twelve hours. If the four hour method is used the coagulation time must be determined just before an injection. The heparin is continued until the dicumarol has caused a drop in the prothrombin percentage into the 60's.

Dicumarol is started at the same time as the heparin. The initial dose is 300 mg. for a patient over 150 pounds and 200 mg. for a patient under 150 pounds. The prothrombin time is determined every morning. The daily maintenance dose of dicumarol is given in the afternoon after the morning prothrombin time is known (this is the most important rule to follow). The daily maintenance dose of dicumarol is 100 mg. This daily dose is given until the prothrombin percentage has fallen into the 60's where it should be maintained.

When the prothrombin percentage is in the 60's the daily dose is discontinued. A dose of from 100 to 200 mg. is given thereafter when the prothrombin time shows a tendency to rise. If it should jump back into the 80's the 200 mg. dose should be given but if it is rising only slightly the 100 mg. dose should be given. Thus the daily prothrombin time determines the maintenance dose. The prothrombin time is kept as near the 60's as possible until the patient is up and out of bed without incident.

The patient is allowed out of bed when all clinical signs of thrombophlebitis are out of the leg except swelling which of course may persist for a long time. The general surgical condition of the patient is the determining point when the patient is allowed out of bed. The point is to have the patient out of bed with a prolonged prothrombin time and therefore an anticoagulation effect going on.

If the patient has had signs of reflex arterial spasm in the affected leg such as absent or reduced pulses, a white cold foot or swelling a series of three paravertebral sympathetic procaine blocks is performed.

If the patient is over 50 years of age and has had a warning benign embolism venous ligation is seriously considered and both sides should probably be done unless a venogram on the supposedly normal side is satisfactory evidence of freedom from trouble.

SUMMARY

In a period of two and a half years 55 patients who were regarded as having potential pulmonary embolism have been treated with di-

cumarol therapy with or without heparin at the beginning of treatment. One subsequent benign pulmonary embolism occurred and 1 fatal pulmonary embolism after the dicumarol effect had worn off. One subsequent area of thrombophlebitis developed in 1 patient during a period of inadequate treatment. The technic of anticoagulation therapy is described.

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TREATMENT OF THROMBOPHLEBITIS BY PARAVERTEBRAL SYMPATHETIC BLOCK

MORRIS J. NICHOLSON

Venous intravascular clotting is at best a very disabling disease and all too frequently terminates tragically. Although much clinical and experimental work has been done to determine the pathogenesis of this disorder no single causative factor has yet been found.

In this paper the factors predisposing to intravenous clotting with their correction will be mentioned. The differential diagnosis of the various types of phlebitis of the lower extremities will be given while one type of treatment of femoro iliac thrombophlebitis (phlegmasa alba dolens) will be stressed.

PREDISPOSING FACTORS

Most authorities agree that anemia, venostasis, dehydration, infection, trauma and certain biochemical changes in a person's blood favor coagulation and thrombophlebitis. These biochemical changes are the subject of Bancroft's^{1, 2} clotting index. The correction of these predisposing factors should they exist is a logical step in the prevention of this condition. Our greatest hope in the prevention of thrombophlebitis and its sequelae lies in this method of approach rather than in treatment. Bancroft¹ says that proper diet and the intravenous use of sodium thiosulfate will restore to normal those individuals who by his clotting index are found to possess an abnormal rapid clotting tendency. Fischer¹¹ has stressed the importance of compression bandages to obliterate the superficial varicosities in the lower extremities. When these are used before and after operation it increases the blood flow in the deep venous system and thus tends to diminish the possibility of thromboses in both the superficial and deep veins. As immobility is responsible for circulatory retardation, Wangensteen³ has suggested that the postoperative patient be instructed to move his extremities at least a thousand times a day.

Barker⁵ says that a careful preoperative study should be made of those patients who have residual findings of previous thrombophlebitis. He found that of 46 patients with a history of thrombophlebitis occurring less than one year prior to operation 31 developed some type of pulmonary embolism. Fifteen of these were fatal. With the valuable information regarding the increased risk in this type of case the routine postoperative use of some type of anti coagulant therapy (heparin¹⁷ or dicumarol¹⁹) to protect against thrombosis or embolism must be seriously considered.

DIAGNOSIS

Since the treatment is different and the risk of pulmonary embolism varies with the different types of thrombophlebitis a brief review of the more common varieties found in the lower extremities seems pertinent.

Thrombophlebitis of Superficial Varicose Veins.—Thrombophlebitis is seen more frequently in superficial varicose veins. The thrombus, in breaking free of the walls of the vein with its feeble or reversed circulation probably accounts for the development of this condition. Pulmonary emboli rarely follow thrombosis in a varicose vein. Proper treatment during the acute stage, followed by ligation of the great saphenous vein at its entrance to the femoral vein, retrograde and subsequent peripheral injections yield a high percentage of cures.

Phlebitis Migrans.—When thrombophlebitis occurs in a nonvaricose superficial vein one should think of phlebitis migrans, which so often complicates thrombo-angitis obliterans (Buerger's disease). If the onset is without obvious cause and a segment of the vein an inch or two in length (almost always on the surface of the lower leg) becomes solid, thickened and slightly tender, if this thickening remains constant for a week or two then softens and apparently returns to normal, while another area of thrombophlebitis proximal to the first appears, a presumptive diagnosis of phlebitis migrans should be made.

On such a case in our series was treated by the method to be described, without benefit and later had a local excision of the thrombosed area of vein plus a central ligation. This patient also showed the associated diminished arterial supply to the involved extremity which generally can be improved by surgical interruption of the sympathetics.

Superficial Thrombophlebitis Unassociated with Buerger's Disease.—This type of thrombophlebitis is actually more frequent and unaccountable than phlebitis migrans, generally occurring in locally dilated veins which are not a part of a varicose saphenous system. Such trivial local irritation as chafing or exposure to unusual cold may initiate this condition. This process reappears without cause and may extend to the great saphenous system giving rise to an embolus. In an obese woman the differential diagnosis between local lymphangitis and mild cellulitis may be rather difficult. To prevent frequent local recurrences and occasional emboli the great saphenous vein should be ligated at the junction with the femoral.

Phlebothrombosis.—Homans and others^{1, 2, 3, 4, 5, 6} have accumulated much information in recent years to show that a large majority of the pulmonary emboli of extracardiac origin are from the deep veins of the lower extremities. This type of intravenous clotting now called phlebothrombosis may occur during active life from the most trivial cause but is most often seen during postoperative convalescence. Here the clot is felt to be due to venostasis and to alterations

in the cellular and fluid constituents of the blood. Being unassociated with inflammation of the vein the clot is of the coagulation variety loosely attached to the vein wall permitting its being loosened easily with the development of an embolus (Fig. 270).

Of particular importance is the *insidious onset* of phlebothrombosis with frequent lack of indicative clinical symptoms. The patient may

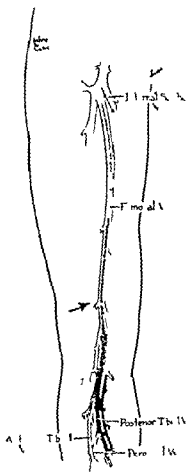


Fig. 271. Thrombosis of the deep vein of the calf. The thrombus is if it dislodged, it would travel toward the heart.

have a sense of impending danger, exhibit a pulse rate out of proportion to anything else, and have tenderness over the involved vein. Often there is a complaint of a tight feeling in the involved calf muscle with pain there and in the back of the knee, which is exaggerated when the tendo achillis is stretched by forced passive dorsiflexion of the foot (Homan's sign). When a patient is seen in this early stage, ligation and division of the femoral vein distal to the profunda branch

is indicated to prevent central progress of the clot or pulmonary embolism.¹⁰

A precise method of diagnosis is therefore desirable if a lowered mortality rate in pulmonary emboli is to be obtained and herein lies the importance of *phlebography* (venography). Dos Santos⁵ described a method of phlebography and Bauer⁶ elaborated upon it and emphasized its value. Others⁴ have attested to the value of this diagnostic aid in early diagnosis and localization of intravenous clot of the lower extremities.

Femoro-iliac Thrombophlebitis—Everyone is familiar with the typical femoro-iliac thrombophlebitis or *phlegmasia alba dolens* so likely to follow operation or injury in persons in or beyond middle life (Fig. 771). However it frequently occurs in young women after childbirth, and in young adults after an acute febrile condition or simple operation such as an appendectomy. Its onset is usually sudden, with definite clinical manifestations such as fever, swelling and pain in the groin which occasionally is severe enough to suggest arterial occlusion. Clotting is believed to be the result of injury to vascular endothelium from mechanical trauma, bacterial invasion or chemical injury. The clot is firmly adherent to the vein wall and is less likely to become detached and to result in embolism. Swelling may appear at times without pain or elevation of temperature but as a rule the pulse and temperature are elevated for twenty-four hours preceding the episode. As the edema increases and the skin becomes tight and glistening the leg may assume a cyanotic appearance which indicates generalized vasoconstriction.

The course of femoro-iliac thrombophlebitis may be extremely variable. A mild form may cause only moderate edema which disappears after ten to fourteen days' rest in bed. A severe form, associated with high fever and generalized toxemia, may require a prolonged convalescence leaving the patient with a chronically swollen and unyielding leg. Other patients develop involvement of the opposite leg with subsequent pulmonary emboli. Only rarely does a pulmonary embolus arise from the original area of thrombosis. It is not uncommon however for a patient to develop the classical signs of *phlegmasia alba dolens* after a pulmonary embolism. Barker⁴ says: "Once the signs and symptoms of femoral and iliac thrombophlebitis appear the danger of pulmonary embolus is comparatively small. In a statistical study of 116 consecutive cases of fatal postoperative pulmonary embolism, thrombophlebitis of the femoral and iliac veins which could be recognized clinically was present in only five cases. In one case the pulmonary embolus appeared the day after the onset of thrombophlebitis. In the other cases the embolism was demonstrated at necropsy actually to have come from a fresh thrombus in the iliac vein of the leg opposite to the one in which thrombophlebitis had been present earlier. Conversely, in a series of 54 cases of postoperative femoral

PARAVERTEBRAL SYMPATHETIC BLOCK

In view of this fundamental difference in femoro iliac thrombophlebitis as compared with phlebothrombosis we feel justified in subjecting patients suffering from the former to paravertebral parasympathetic block as it increases their chance of a speedy and complete recovery without increasing the frequency of pulmonary emboli.

This relatively new form of treatment was first described by Leriche and Kunlin¹⁶ of France in 1934. They reported 3 cases of acute postoperative phlebitis in which treatment by novocain block of the lumbar sympathetic ganglion was successful. Since 1934 this method

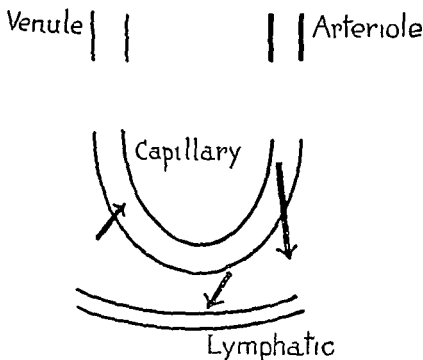


Fig 222—Diagram of normal physiologic relationship of intravascular and perivascular fluids. As indicated by the arrows normally there exists a balance between the amount of fluids leaving the blood vessels and entering the tissue and that leaving the tissues and entering the blood and lymphatic vessels. (From Ochsner A and DeBakey M. JAMA 114:117 [Jan 13] 1940.)

of treatment has been used successfully in Europe while credit for its further clarification and popularization in this country belongs to Ochsner and DeBakey.¹⁷

According to Leriche and Kunlin¹⁶ clinical manifestations in thrombophlebitis are due to the establishment of a vasomotor reflex as a result of impulses originating in the thrombus venous segment. They are of the opinion that there are three dominant factors in this process: (1) amount of vein involved, (2) arteriospasm and (3) venospasm. The last factor is the most constant and significant.

Ochsner and DeBakey, after much clinical and experimental work,

believe that arteriospasm is of equal or more importance than venospasm. They agree with Ierliche and Kunlin that the clinical manifestations are due largely to the vasomotor reflex which originates in the thrombosed venous segment, that the symptoms can be relieved completely and that the convalescence can be shortened materially by blocking the sympathetics to break this vasomotor spasm. That a

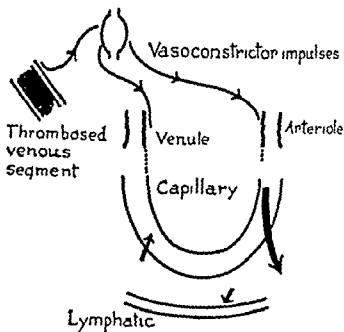


Fig. 23—Diagram of production of edema in thrombophlebitis. As the arrows show, the effect is a greater amount of fluids leaving the blood vessel and entering the tissues than that leaving the tissues and entering the blood and lymphatic vessels. The increased transudation of fluids from the vascular system to the perivascular spaces is due to several factors. As a result of vasoconstrictor impulses initiated in the thrombosed venous segment, there is produced a reflex vasoconstriction involving both the arterial and the venous elements of the vascular tree. Thus the effective mechanical pressure within the vessel is increased with consequent augmentation of filtration pressure and relative noxia of the perivascular space, both of which favor an increased transudation of vascular fluid to the perivascular tissue. The mechanical stimulation of peripheral pulsation contributes to vasospasm and increased venous pressure, which in turn decreases lymphatic flow and a stagnation of tissue fluid. (From Ochsner and DeBakey, *JAMA* 114:117 [Jan. 13] 1940.)

localized thrombophlebitic process can initiate a marked arteriospasm is illustrated by numerous reports in the literature in which the onset of phlebitis was considered to be an arterial embolus.

A thorough and detailed account of the disturbed physiology of thrombophlebitis as set forth by Ochsner and DeBakey is shown in Figures 222, 223 and 224.

The technic for injection of the paravertebral lumbar sympathetic ganglion is very simple and may be performed with the patient in bed. Whenever possible morphine and a short acting barbiturate should be administered one hour previously to allay apprehension and to protect against possible toxic effects of the local anesthetic. With the patient in the lateral decubitus position with the affected side up the skin over the lumbar vertebrae is prepared and draped in a sterile fashion.

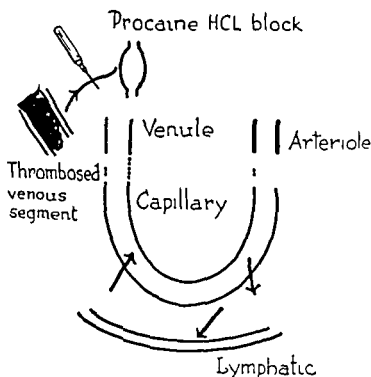


Fig. 4—Diagram of mechanism by which procaine hydrochloride block produces improvement in thrombophlebitic edema. Interruption of the vasoconstrictor impulses results in a decrease in venous pressure, increased vascularity and increased peripheral pulsations. The diminished venous pressure results in decreased filtration pressure and thus tends to prevent increased transudation of vascular fluid into the perivascular spaces. Increased vascularity reestablishes normal oxygenation of the vascular endothelium and permits return of normal permeability which prohibits excessive transudation. Increased pulsations favor removal of perivascular fluids by increasing lymph flow. (From Ochsner A and DeBakey M. JAMA 114:117 [Jan 13] 1940.)

Skin wheals are made on the affected side by intracutaneous injection of 1 per cent procaine hydrochloride to each 100 cc of which 0.5 cc of 1:1000 epinephrine has been added. Skin wheals are made at points approximately 4.5 to 5 cm lateral to the upper part of the spinous processes of the first, second, third and fourth lumbar vertebrae. These points are chosen as they lie immediately over the transverse processes of the corresponding lumbar vertebrae. A 20 gauge needle 10 cm in length is used for the sympathetic

block. The needle is inserted through each wheel perpendicular to the skin for a distance of 4 or 5 cm and should encounter the transverse processes (Fig 225). The needle is withdrawn a little and directed superiorly so that it can pass between and beyond the transverse processes and is pointed slightly toward the midline. After the needle is inserted for another 3 or 4 cm in this new direction, it will impinge against the anterolateral surface of the body of the vertebra in the retroperitoneal space (Fig 226).

After careful aspiration to insure against intravascular injection, 10 cc of 1 per cent procaine hydrochloride solution is deposited at each

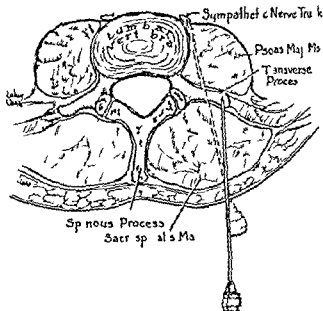


Fig 225—Cross section through region of second and third lumbar vertebrae showing course of needle for sympathetic block. Skin wheel is made 4 to 5 cm lateral to spinous process. Needle is inserted vertically until it encounters process, is retracted then withdrawn slightly and inserted 4 cm beyond transverse process until point lies along anterolateral surface of body of vertebra to contact sympathetic chain.

site. The solution is most often deposited near rather than directly on the sympathetic ganglion so a 5 to 10 minute delay is usually necessary before the real effect can be ascertained. Following the injection the leg feels subjectively warmer, the pain is markedly decreased, arterial pulsations improve, and the patient generally has an area of hyposensitivity to pinprick extending from the iliac crest to just below the knee on the injected side.

Since June 1939 this form of treatment has been used at the Lakeside Clinic for a great many patients suffering from thrombophlebitis of the lower extremities. Most of them had the acute form of thrombo-

phlebitis with marked pain edema and elevation of temperature. However some had passed this stage and were in the subacute or chronic stage. The duration of symptoms before the institution of treatment varied from three to fourteen days but in 1 patient the thrombophlebitis dated back nineteen months and in another four and a half years. A few of the patients in this series had pulmonary emboli be-

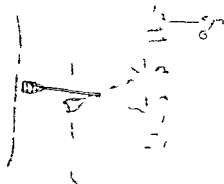


Fig. 6—Technic for lumbar sympathetic block in thrombophlebitis of lower extremity. Patient is in the lateral decubitus position. Needle is inserted through skin 4 to 5 cm lateral to the lower part of the spinous processes of the first four lumbar vertebrae. When needle encounters the respective transverse process, withdraw needle slightly, change direction and insert 4 cm more to encounter sympathetic chain.

fore any signs of thrombophlebitis could be recognized clinically. The time interval between pulmonary emboli and phlebitis varied from four days to three weeks.

It is difficult to predict the number of treatments each patient will require. Some have been relieved with one while others have received as many as five. Ochsner³ believes and we agree that sympathetic block should be performed daily until the patient's temper-

block. The needle is inserted through each wheal perpendicular to the skin for a distance of 4 or 5 cm and should encounter the transverse processes (Fig 25). The needle is withdrawn a little and directed superiorly so that it can pass between and beyond the transverse processes and is pointed slightly toward the midline. After the needle is inserted for another 3 or 4 cm in this new direction it will impinge against the anterolateral surface of the body of the vertebra in the retroperitoneal space (Fig 27c).

After careful aspiration to insure against intravascular injection 10 cc of 1 per cent procaine hydrochloride solution is deposited at each

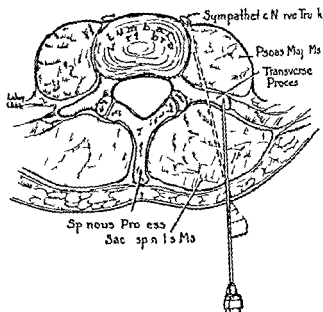


Fig 25—Cross section through region of second lumbar vertebra showing course of needle for sympathetic block. Sympathetic trunk is reached 4 to 5 cm lateral to spinous process. Needle is inserted vertically until transverse process is reached then withdrawn slightly and inserted 4 cm beyond transverse process until point strikes anterolateral surface of body of vertebra to enter sympathetic chain.

site. The solution is most often deposited near rather than directly on the sympathetic ganglion so a 5 to 10 minute delay is usually necessary before the real effect can be ascertained. Following the injection the leg feels subjectively warmer, the pain is markedly decreased, arterial pulsations improve, and the patient generally has an area of hyposensitivity to pinprick extending from the iliac crest to just below the knee on the injected side.

Since June 1939 this form of treatment has been used at the Lakes Clinic for a great many patients suffering from thrombophlebitis of the lower extremities. Most of them had the acute form of thrombo-

Chronic Thrombophlebitis—The results of treatment of chronic thrombophlebitis by paravertebral sympathetic block have not been so encouraging. This treatment when combined with bed rest generally has given these patients a period of freedom from pain with return of the legs to normal size but when normal activity was resumed, edema reappeared after the leg had been in a dependent position for six to eight hours.

Ochsner¹³ believes this is due to two factors: first a certain amount of fibrosis which results from prolonged edema with increase in tissue protein, and secondly the presence of vasoconstriction which is evidenced by the fact that the patient is relieved temporarily by sympathetic block. A more prolonged vasodilatation is necessary and if it were not for the complicating neuritis an alcohol block would be ideal.

Conservative measures such as encouragement of reflex vasodilatation by immersing the hands and arms in hot water for twenty minutes two or three times a day and the avoidance of vasoconstrictive influences such as smoking and exposure to cold may be beneficial. The patient also should be instructed to prevent edema by applying a compression bandage before arising and elevating the extremity whenever possible. If these conservative measures fail then the more radical method of producing vasodilatation through lumbar sympathectomy will be necessary.

SUMMARY

Factors predisposing to intravenous clotting and certain measures believed to be helpful in their prevention are discussed. Phlebothrombosis and thrombophlebitis are differentiated and a relatively new method of treatment for the latter is described. A detailed account of the supposed disturbed physiology as seen in thrombophlebitis is given. The technic for paravertebral lumbar sympathetic block is described.

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GAS BACILLUS INFECTION FOLLOWING BILIARY SURGERY

Report of Three Cases

RALPH ADAMS

In this paper I wish to report a rare and fatal complication of biliary surgery that has occurred three times in a series of 4221 biliary tract operations at the Lahey Clinic during the last thirty three years

REPORT OF CASES

CASE I—A 51 year old shop foreman had a cholecystectomy and choledochostomy performed on October 25 1934 for chronic cholecystitis and subacute pancreatitis. He recovered and returned to work but six months later he developed symptoms and signs of intermittent common duct obstruction. On May 21 1935 choledochostomy again was performed with removal of much detritus and a 5 mm stone impacted at the ampulla of Vater. The ampulla was dilated the common duct was drained with a T tube and Morison's pouch with a cigaret drain both being brought out through the abdominal wound. He was returned to bed in good condition with a pulse rate of 90 and a blood pressure reading of 110 mm of mercury systolic and 60 mm diastolic compared with admission readings of 140/80.

Twelve hours postoperatively within a period of two hours a syndrome then interpreted as surgical shock appeared. The blood pressure dropped to 60/40 and the pulse rate rose to 150 with a temperature of 99.6 F. Three transfusions were given during the next twenty four hours and the blood pressure rose to 80/60. The pulse rate remained around 130. He was restless and his face was flushed. The abdomen had become diffusely tender and tympanitic and there was a disagreeable odor about the cigaret drain.

On physical examination the lungs were clear but the color was slightly cyanotic. The clinical picture of shock then was thought secondary to peritonitis. The white blood cell count was 6800 with a differential count of polymorphonuclear leukocytes 95 per cent lymphocytes 2 per cent and monocytes 3 per cent. The urinary excretion failed the temperature gradually rose to 104.5 F and the patient died forty-one hours after operation.

Between the time of death and of autopsy (six hours) crepitation developed in the lower abdominal wall and the scrotum became distended by gas. At autopsy gas hissed from the peritoneal incision. The right rectus muscle showed marked dissolution and was transformed into a soft jelly like substance. Within the peritoneal cavity there was a moderate quantity of serosanguineous fluid. The loops of intestine had a peculiar grayish pink color but were not distended or adherent. The T tube catheter was found inserted snugly into the common duct and no visible leakage had occurred. The mesenteric lymph nodes were not enlarged and no pus was found anywhere. The splenic tissue was soft and necrotic and displayed crepitation. Examination of the thoracic viscera was negative. Microscopically many gas forming bacilli (*Bacillus histolyticus*) were found in the abdominal muscles spleen and blood stream.

CASE II—A 79 year-old woman was admitted to the Clinic on June 25 1935 because of one month of illness characterized by eight extremely severe attacks of epigastric pain and jaundice in two of which she had fainted. Each attack ended with the passage of a large loose bowel movement followed by the disappearance of jaundice. Despite her advanced age and poor general condition the severity of her symptoms rendered operation imperative. Cholecystectomy and cholecystostomy were performed on July 3 1935. The common duct was 1 cm in diameter and contained three large stones. After the removal the ampulla was dilated and there was some reflux of duodenal contents into the common duct. A T tube catheter from the duct and a cigarette drain from Morrison's pouch were brought out through the abdominal wound.

The patient's condition seemed satisfactory for twelve hours and then deteriorated rapidly the clinical picture being that of atypical surgical shock, with blood pressure readings of 96 mm of mercury systolic and 60 mm diastolic, compared with preoperative readings of 140/70. The pulse rate was 130. Cyanosis of the finger tips was present. The temperature was 101° F. The abdomen became tympanitic. She failed to respond to supportive therapy and died twenty-four hours after operation.

The autopsy findings were similar to those of Case I the essential feature being generalized gas bacillus bacteremia (*Bacillus welchii*). There was no free fluid in the abdomen but a foul odor was detectable about the wound. The rectus muscle tissue alongside the incision showed autolysis. On section gas bubbled from some of the liver sinuoids.

CASE III—A 62 year-old housewife had a cholecystectomy cholecystostomy and repair of a 5 cm hiatus hernia on January 16 1943 for intermittent common duct obstruction and esophageal regurgitation in the recumbent position of thirty years duration. The hiatus hernia was repaired simply by approximation of the diaphragmatic muscle fibers to close the defect alongside the normal esophagus. A large quantity of small stones was removed from the common duct, and the ampulla was dilated until a No. 7 Bick's dilator passed through it into the duodenum. A T tube catheter from the common duct and a cigarette drain from Morrison's pouch were brought out through the abdominal wound. There was no dental appendectomy.

The patient's course was satisfactory until the fourth postoperative day when a foul odor appeared in the T tube drainage. Sulfomide therapy was started and thereafter continued. On the sixth day slight necrosis was evident along the tract about the T tube. On the eighth day she showed signs of mild shock with decrease of the normally high blood pressure of 20 mm of mercury systolic and 120 mm diastolic. The shock steadily deepened with lowering of the blood pressure to 80/40 and rate of pulse rate to 150 the temperature remaining about 100° F.

While efforts were being made to elevate the blood pressure with intravenous supportive treatment the patient developed cerebral thrombosis with left hemiplegia and inability to swallow. Although her blood pressure returned to 160/100 and the pulse rate dropped to 100 she looked very sick. The white blood cell count was 37 000 with 91 per cent polymorphonuclear leukocytes 6 per cent lymphocytes and 3 per cent monocytes. Smears taken from the wound on the eighth day showed a great variety of organisms with streptococci predominant but no gram positive rods or spore bearing organisms were seen. Hemocultures demonstrated *B. welchii* and intensive antitoxin treatment was carried out.

until death. On the twelfth day a localized collection of pus was discovered between the liver and the stomach and evacuated through the wound. She died later the same day.

Autopsy demonstrated acute purulent peritonitis localized to the region above the transverse colon apparently originating from the common duct. The small intestine and lower peritoneal cavity were uninvolved. There was also puriform pancreatic necrosis and all purulent exudate contained *B. welchii* as the predominant organism. There was also thrombosis of a right meningeal vein and focal cortical hemorrhages.

DISCUSSION

The correct diagnosis was not made in the first 2 cases until autopsy. In the third case the possibility was realized early because of similarity of course with the preceding ones but vigorous antitoxin and sulfonamide treatment did not alter the progress to a fatal outcome. Unfortunately we do not know what caused the anaerobic infection to develop in these 3 cases.

In certain cases of putrid empyema of the gallbladder it has been our practice to give gas bacillus antitoxin prophylactically but none of these patients had fever or signs of sepsis preoperatively or at operation. Each had the standard type of technical procedure that has been used uniformly at the Lahey Clinic for many years in the search for and removal of common duct stones and excision of the gallbladder. In each the ampulla of Vater was dilated by the passage of a Bakes dilator through it into the duodenum in accordance with our common practice.

The backing of duodenal contents into the common duct has been suspected as the source of the infection although this has not been proved. Such reflux must be quite frequent after dilatation of the ampulla and drainage of the common duct. On the other hand dilatation of the ampulla has so much merit that it cannot be discontinued on this supposition. We have however advised that the catheter ordinarily introduced into the duct for flushing it with saline at completion of the search for stones be kept within the duct and not passed through the ampulla for distention of the duodenum with saline as has been done to prove clear passage from the duct into the duodenum.

Not only was the cause of this infection unknown but also we have been practically helpless to control it after recognition. It seemed as though the third patient might survive. Her death occurred before penicillin therapy was available but she had maximal doses of sulfa diazine and gas bacillus antitoxin and all supportive therapy without apparent effect.

SUMMARY

Three cases of fatal gas bacillus bacteremia as a complication of biliary surgery are described. The clinical features were (1) an abrupt change from an apparently normal convalescence (2) a low blood pressure rapid pulse cyanosis without air hunger moderate fever and (3) a foul odor from the wound.

CAUSES OF FEVER FOLLOWING ABDOMINAL OPERATIONS

FRANK H. LAHEY

With modern methods of asepsis clean abdominal operations to day can be undertaken with the expectation exclusive of the two or three immediate postoperative days of no marked elevation of temperature. It is therefore of concern to every surgeon when an elevation of temperature persists following a clean abdominal operation.

When one deals as we do at the Clinic with a large number of major abdominal operations such as operations on the pancreas and common duct and resections of the stomach, colon and colon and rectum, the possible causes of postoperative fever become quite definitely established in mind.

In sequence in postoperative fever one should first investigate the wound, secondly the chest and thirdly the urine and kidneys for a possible cause.

WOUND INFECTION

Perhaps the simplest, most common and most easily handled cause of immediate and persistent postoperative fever is localized wound infection. Certainly when fever persists, one should investigate the wound for a possible small localized accumulation of pus. If there is such a localized accumulation, it should be drained at once. This often will prevent spread of the infection to the entire wound with loss of sutures, a prolonged hospital stay and a certain ventral hernia.

Whenever therefore postoperative fever persists, it is of advantage with aseptic precautions and the wound painted with iodine to palpate the wound for indurated spots from the bottom to the top, picking up the skin and subcutaneous fat between the thumb and forefinger. Often by means of this grasp of the entire skin, subcutaneous fat and fascia between the fingers, a particularly localized area of induration can be felt, an area of tenderness beyond the wound may be palpated and a small hematoma which may become infected or a small area which already has become infected may be distinguished. Under such conditions it is justifiable to introduce under the most aseptic precautions a small director through the skin edges into the questionable area. After early discovery of such an area, local drainage often has sufficed. If the infection is permitted to continue, the wound becomes completely involved and presents a much more serious problem.

ATELECTASIS

For a great many years it has been assumed that the postoperative temperature reaction present in practically all patients upon whom a

laparotomy has been done is the result of absorption in the peritoneal cavity of blood or the effects of the trauma upon the peritoneal cavity. While one cannot be sure this always has impressed me as unlikely. Certainly within the last ten years I have felt that the constant temperature rise after laparotomy was more commonly of pulmonary origin secondary to mild degrees of lobular atelectasis.

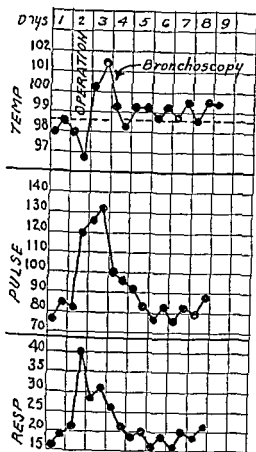


Fig. 8—Clinical chart of a man aged 47 years who had an abdominoperineal section of the rectum for carcinoma. Thirty-two hours postoperatively he complained of respiratory distress. The respirations rose to 40, the pulse to 130 and the temperature to 101.4° F. There was dullness over the right lower chest with absence of breath sounds and slight cyanosis of the fingernail base. Roentgenogram showed some cloudiness near the right base and slight elevation of the right diaphragm. Suction bronchoscopy was performed with immediate and definite clinical improvement. Another roentgenogram taken six hours later showed considerable clearing of the right lung field with a return of the mediastinum toward the midline.

Since a patient during his immediate convalescence tends not to cough and completely clear the bronchial tree of mucus because the abdominal wound is painful it seems probable that nearly all patients during this period at times have very slight degrees of atelectasis with absorption of the retained organisms and toxic products through the alveolar epithelium.

Nearly every physician is familiar with the typical atelectasis which so frequently follows in abdominal operation and the effect upon the temperature and pulse rate of the relief of the atelectasis by suction bronchoscopy (Fig 228). Up to the time when suction bronchoscopy was so well popularized by Chevalier Jackson and Gabriel Tucker probably a great many patients suffered from avoidable postoperative pneumonia.

Therefore every unexplained postoperative rise in temperature, particularly in laparotomized patients should be considered as possibly due to atelectasis. The signs of atelectasis usually are so definite that their discussion is hardly necessary—a rise in temperature at the typical time, a change in physical findings and roentgenologic evidence of massive lobar or lobular collapse so often associated with displacement of the trachea particularly in massive collapse.

Postoperative fever of possible atelectatic origin should be investigated early. There seems little question that if atelectasis is permitted to exist over a considerable period of time it will progress to a pneumonia which in turn will result in an avoidable pneumonia.

In discussing postoperative atelectasis I frequently have said that the patient with postoperative temperature rise of possible pulmonary origin in whom the roentgenologic diagnosis is bronchopneumonia should be observed carefully. The roentgenologic picture of patchy atelectasis can so simulate that of bronchopneumonia that the two conditions are indistinguishable. More than once I am certain bronchoscopy has been omitted when the diagnosis was thought to be bronchopneumonia and the condition was patchy atelectasis. The relief of the atelectasis would have avoided bronchopneumonia which eventually and avoidably occurs unless the bronchial tree is sucked out. Perhaps no temperature reaction following laparotomy lends itself better to relief than that due to atelectasis relievable by suction bronchoscopy.

KIDNEY INFECTION

When the rise of temperature in laparotomized patients is unexplainable and of considerable height (103° or 104° F.) with no physical findings whatever in the abdomen or chest I always have felt that it probably was of kidney origin. A higher temperature without other symptoms can occur in a patient with an abdominal operation and postoperative kidney infection than in almost any other condition.

PELVIC ABSCESS

Perhaps the next most common cause of postoperative temperature reaction is pelvic abscess particularly if contamination already was present and could have occurred by spilling such as in operations for acute appendicitis, gangrenous bowel, any type of perforation of the abdominal viscera or resection.

Nothing in my whole surgical career has caused me to err more frequently in preoperative and postoperative diagnosis than the failure to do frequent and adequate rectal examinations. Therefore to the examinations of the wound, chest and urine and kidneys should be added a rectal examination. The rectal examination should be sufficiently high because the indurated areas in the early stages of pelvic abscess are both lateral and high in the pelvis. Not only is a rectal examination necessary in investigating the cause of postoperative fever but it should be repeated daily until a diagnosis is made. Too often the rectal examination is negative and then four or five days later a pelvic abscess which should have been found earlier can be palpated through the rectum.

Pelvic abscesses in women can be reached through the vagina and in men can be drained through the rectum. Contrary to what one would expect puncture of a pelvic abscess through the rectum is eminently satisfactory. One needs only to be certain that it is clearly fluctuant and is drained through this fluctuant spot. A rectal puncture for possible pelvic abscess under no circumstances should be made when the area is only indurated and not fluctuant. The drainage hole usually remains open, the cavity drains adequately and the temperature comes down and remains down.

SUBDIAPHRAGMATIC ABSCESS

Subdiaphragmatic abscess is a common cause of persistent and in the beginning unexplained postoperative fever. It is particularly apt to follow an operation for gangrenous appendicitis, infected gall bladder and a perforated duodenal or gastric ulcer.

The diagnosis of subdiaphragmatic abscess depending upon its location and extent, can be simple or most baffling and difficult. In the presence of persistent and unexplained fever the intercostal spaces over the subdiaphragmatic area on each side should be investigated carefully for edema, obliteration and tenderness on fist percussion. On roentgenologic examination gas within the abscess cavity as is frequently the case beneath the diaphragm immediately will demonstrate the presence of the abscess. One should look for fixation, elevation of the diaphragm with sharpening of the acuteness of the costophrenic angle and fluid within the pleural cavity as a secondary reaction to the inflammatory process below it.

If tapping for a possible subdiaphragmatic abscess is to be performed particularly if the needle is to be inserted high the possibility that the pleura will be contaminated always must be considered and one should be prepared to operate if pus is found. If the abscess cavity is entered there is always the possibility that the needle will penetrate the parietal and diaphragmatic pleura thus producing the possibility of pleural contamination. With immediate operation the two leaves of the diaphragm can be sutured and immediate de-

compression of the abscess can be instituted otherwise the pleural puncture can result in leakage of pus into the pleural cavity with the production of secondary empyema.

The transdiaphragmatic and transpleural approach of subdiaphragmatic abscess as well as the extraperitoneal approach have been so well described that no further discussion is necessary.

INTRAPERITONEAL ABSCESS

Little need be said regarding intraperitoneal abscess except that abdominal exploration for an undemonstrated unfluctuant peritoneal abscess which is not adherent to the abdominal wall is extremely dangerous. For years I have advised my associates and assistants that if an intraperitoneal accumulation of pus is suspected, exclusive of pelvic abscess, operation should be delayed until the mass can be palpated until it is discrete and if possible until it is so adherent to the abdominal wall that it can be approached without opening the general peritoneal cavity.

Sometimes an intraperitoneal abscess is in such a location that it will not become adherent to the abdominal wall. In such a case one should wait until the mass is definitely discrete and convincingly palpable and then under spinal anesthesia with the abdominal wall completely relaxed a small opening can be made in the abscess cavity; its contents can be carefully sucked out and a dressed cigarette drain can be inserted so that dissemination of the contents is prevented.

In all unexplained postoperative fever particularly when the infection is within the portal circulation and follows inflammation of the right colon the possibility of a pyelophlebitis must be kept in mind. The fever is usually of such height the constitutional reactions are so severe and the toxic appearance is so typical that the diagnosis is evident.

REMOVAL OF DRAINS

Postoperative fever sometimes is the result of removing abdominal drains too early. If an abdominal drain is inserted because of a real abscess obviously the drain should not be removed until an adequate drainage tract which will remain open exists. We always have been strongly opposed to the use of the so called prophylactic drain. When a drain put in at the time of operation can be removed in twenty-four to sixty hours in all probability it was unnecessary in the beginning. If a drain is left in place for a minimum of seven or eight days there is spindle cell formation within the wall and when it is removed there is a good drainage canal down to the abscess cavity and contaminated area or the area suspected of possible leakage. From our experience we are sure that the occasional residual abscess following the early removal of a drain and the resulting elevation of temperature can be avoided if drains are not removed before a minimum of seven or eight days.

A drain should be removed not a little at a time but all at once. If it comes out easily it can be removed without an anesthetic. If it is adherent and attempts at removal are painful the patient can be given either vinyl ether or intravenous pentothal.

When a drain is removed at the end of seven or eight days either a strip of rubber dam or a catheter should be introduced to the lowest point of the drainage canal. This can be withdrawn gradually as the drainage ceases and by this plan we have had almost no difficulty with so called residual abscesses causing postoperative fever.

CONCLUSIONS

Unexplained postoperative fever should be investigated in the following order:

- 1 Wound for infection
- 2 Chest for possible postoperative pulmonary atelectasis
- 3 Urine for kidney infection
- 4 Pelvis for abscess
- 5 Subdiaphragmatic area for abscess
- 6 General abdomen for possible intraperitoneal walled off accumulation of pus

MANAGEMENT OF INTESTINAL DISTENTION (ADYNAMIC ILEUS) WITH SPECIAL REFERENCE TO POSTOPERATIVE DISTENTION

EARL J BOEHME

NONMECHANICAL obstruction and distention of the bowel present a major problem in diagnosis and management. Since this condition is a manifestation of a wide variety of pathologic processes and disturbances in physiologic function it defies accurate classification as a disease entity. It has been variously termed paralytic ileus, adynamic ileus, inhibition ileus, patent inactive ileus, and adynamic obstruction. These names have been retained because of general usage but most of them are inaccurate since the bowel though showing little peristaltic activity is not paralyzed and will respond to stimulation by drugs, spinal anesthetic and the release of the distending gas. The need for a universal definition of this condition becomes apparent when one examines the literature and finds mortality statistics in large series of cases varying from 2 to 93 per cent. For purposes of this discussion adynamic ileus is defined as generalized intestinal distention without mechanical obstruction but associated with other profound pathologic conditions or disturbed physiologic function.

In distention two problems become apparent. The first is the decompression of the bowel in order to facilitate diagnosis of the underlying disease. The second is the control of the distention while either conservative or operative treatment is directed against the primary cause. The accomplishment of both these tasks requires a thorough understanding of the mechanism and effects of distention, a proper correlation of the clinical, laboratory and roentgenologic findings and proper use of suction, decompression, replacement of fluid and electrolyte loss and the maintenance of nutrition.

In this discussion I shall present a practical and direct approach to treatment based on our experience at the Lahey Clinic with a discussion of some of the significant studies being carried on in many centers of the country. One desiring an excellent and comprehensive study of intestinal obstruction should refer to Wanstenstein's *Intestinal Obstructions* with its most comprehensive lists of references.

INCIDENCE

Following nearly every type of surgery in the abdomen there is a mild degree of intestinal distention. In the average case this can be prevented by gentle handling of the bowel and by restricting the oral intake of fluids for the first twenty-four to thirty-six hours after

operation Occasionally one is confronted with an extreme degree of postoperative meteorism This is a serious complication in aged patients and in patients considered poor risks because of chronic inanition and its associated depletion of tissue and plasma proteins It is also dangerous in patients with marked fluid and electrolyte imbalance The actual distention will endanger the competency of suture lines in anastomoses Frequently the success of ventral hernia repair is jeopardized by distention

Ileus associated with peritonitis which is the most common type of serious nonmechanical distention also has the highest reported mortality Actually death rates for ileus should not be reported as such but rather as the death rate of the primary disease process causing the ileus

Three general groups of conditions may exhibit a paralytic ileus

1 Infections and irritations in and adjacent to the peritoneal cavity

2 Trauma strangulations and stone colics

3 General systemic disease

In the first group one finds generalized peritonitis localized peritonitis retroperitoneal and intraperitoneal hemorrhage liver abscess and pancreatitis The last may be recurrent and produce extreme and prolonged distention We have observed a patient with ileus which lasted twelve days in whom pancreatic abscess followed gastric resection with removal of an ulcer penetrating the head of the pancreas

In the second group there is reflex overstimulation of the sympathetic nerves to the intestines or an imbalance between the vagus and sympathetic effects Abdominal operations direct trauma to the abdomen trauma to the central nervous system and spinal cord operations on the lower part of the thoracic cage fractured ribs and hyperextension in a body cast all produce varying degrees of this reflex ileus Strangulation of ovarian cysts and tumors by twisting of the pedicle strangulation of the omentum embolism and thrombosis of the mesentery may cause ileus Renal and biliary tract colic due to stone will cause reflex ileus if prolonged

The mechanism by which some of the general systemic diseases bring about paralytic ileus is not easily understood Generalized sepsis pneumonia meningitis and uremia may present large distention It has been stated that edema and nutritional disorders also will produce ileus Mecray Barden and Ravdin¹⁵ found that edema associated with hypoproteinemia may interfere with the patency of recent intestinal anastomoses particularly after gastric surgery

SOURCE OF GAS CAUSING DISTENTION

Wangensteen concluded that about 68 per cent of gas in the intestine in obstruction has its origin in swallowed air 32 per cent forms within the body About 70 per cent of the latter originated by diffusion of blood gases especially nitrogen into the bowel lumen

The remaining 30 per cent originated within the obstructed loop. Thus less than 10 per cent of all the gas forms from putrefaction and fermentation. He suggests that the swallowing of air is intimately connected with respiration and negative intrathoracic pressure and therefore is accomplished by very slight suction. Also there may be increased air swallowing after operations. Wangenstein and Rea¹⁵ transected the esophagus in dogs, closed the distal end after producing an obstruction of the ileum, and they thus excluded the swallowed air factor in distention. Autopsy showed no abnormal amount of gas in the gut even in those dogs dying of prolonged obstruction.

Our experience at the Lahey Clinic with transthoracic esophagectomy for carcinoma and less extensive operative procedures such as gastrostomy on patients with benign or malignant obstruction of the esophagus has confirmed the absence of any postoperative distention since the possibility of swallowing air is completely prevented. Some of these patients and many patients with abdominal operations may have a mild distention after the third or fourth day. We agree with Puestow¹ who says that this is always gas in the colon and is the result of the inhibition of the colon by morphine. It is usually relieved by enema. Fine, Hurwitz and Marl¹⁶ found that certain foods have a tendency to produce distention and that many foods aid in its prevention.

We feel that our present low incidence of postoperative distention is due chiefly to the use of spinal anesthesia for all abdominal cases rather than inhalation anesthesia fortified with ether or ether alone. The almost convulsive swallowing during the induction of ether and some of the gas anesthetics certainly distends the stomach with air. During the postoperative recovery period swallowing and gagging are common and this may last for many hours. Enormous amounts of air may be swallowed. Morphine given to relieve postoperative pain masks abdominal symptoms. Frequently the patient's abdomen is covered with a heavy dressing and a scultetus binder and not until the second or third day when the patient attempts to drink fluids does the distention become apparent. The intake of fluid into the already overdistended stomach and small intestine induces vomiting with loss of fluids and dechlorination. Spinal anesthesia avoids the initiation of this vicious cycle.

LOCAL AND SYSTEMIC EFFECTS

The effects of distention are dependent on the amount and duration of the distention, on the presence or absence of infection or irritation of the peritoneal surface of the bowel, and on the fluid, electrolyte, and nutritional state of the patient.

In adynamic ileus the bowel is usually uniformly distended. It presents a cyanotic appearance due to venous obstruction. In massive distention it may appear blanched and there may be petechial hemorrhage.

rhages on the surface. There are collections of fluid and gas in the bowel and some free fluid in the peritoneal cavity.

In peritonitis the bowel is lusterless red in color. It may be covered with plastic exudate. There is serous or seropurulent fluid in the peritoneal cavity. Many of the adjacent serous surfaces may be stuck together by the fibrinous exudate, thus increasing angulations of the bowel and producing closed loop obstructions.

The paralytic intestine tolerates distention better than the mechanically obstructed intestine since there are no peristaltic rushes. That there is anoxemia of the bowel wall is evident. Lawson and Ambrose¹ found a rise in the oxygen content of venous blood returning from experimentally obstructed loops in dogs. Since the blood supply is almost constant they reasoned that there are low resistance vascular shunts that open up during distention. Folley¹¹ called attention to the wide difference in the blood supply needed to maintain activity and that needed to support the life of the muscle, as is indicated by the prompt restoration of the intrinsic activity by decompression of the bowel.

Dehydration, one of the first systemic changes to be evident, is brought about because of the reduced fluid intake and the increased fluid loss. Vomiting, sweating, diarrhea, urinary output, exudates and transudates account for the loss. Abbott, Mellors and Muntwyler experimentally obstructed dogs at various levels of the intestinal tract and easily produced dehydration. Abbott and Mellors¹ in a study of plasma volumes in dogs by the Evans blue dye, as described by Gregerson and Stewart, found that prolonged distention and strangulation lowered the total plasma volume and frequently brought early peripheral circulatory collapse when there was an existing dehydration. In human beings they found normal hematocrit and plasma protein determinations in the presence of a serious depletion of the total circulating plasma. Evans⁹ measured the actual local volume loss of plasma in experimentally produced obstruction of the ileum and found that it was enough to account for the fall in plasma volume and blood pressure. Hematocrit increased and the plasma proteins remained unchanged, indicating that if fluid is drawn from the tissue spaces protein comes with it into the blood stream.

Fine, Hurwitz and Mark¹⁰ reported plasma volume studies on patients with distention of the small intestine. The patients showed a marked loss in the volume of the circulating plasma whether the distention was mechanical or paralytic. The plasma volume loss in a small series of cases tended to follow the degree of distention. Effective decompression partially restored the plasma volumes.

A reflex stimulation of respiration is induced by intestinal distention. Crowley⁸ reproduced this in dogs and found that it was initiated by afferent impulses arising from the stimulus of distention and carried by the splanchnic nerves to the spinal cord. Complete section of the

splanchnic nerves or the cord eliminated the respiratory effect, but vagus nerve section had no effect. Patients with distention have a limited costal type of respiration. There is a decrease in the vital capacity and therefore an increased danger of atelectasis.

Intestinal distention interferes with the venous return from the extremities and predisposes the patient to vascular complications. Thrombophlebitis and phlebothrombosis are not uncommon occurrences.

CLINICAL PICTURE

The ballooning up of the patient's abdomen is the most striking feature. This may develop gradually or within a few hours. Frequently the feeling of gas or pressure in the abdomen is the patient's only complaint. There is usually shallow rapid respiration suggesting atelectasis or pneumonia. There is some degree of orthopnea. Many of the so-called ether pneumonias followed atelectasis produced by gastric and intestinal distention. The patient may complain of great thirst and present a dry tongue. Apprehension and restlessness are common. The patient realizes that drinking causes more vomiting. In simple ileus there is relatively little pain in the abdomen.

On examination a distended tympanitic abdomen is found. There is no definite tenderness unless secondary to an inflammatory process but even this is difficult to elicit. On auscultation the abdomen is relatively silent. The pulse is rapid and the blood pressure is usually low.

ROENTGENOLOGIC EXAMINATION

All patients exhibiting this picture should be subjected to immediate roentgenologic examination of the abdomen. Dr. Hare in carrying out these studies in our Department of Radiology makes every effort to obtain not only a scout film of the abdomen but also films taken with the patient in the upright position and in the horizontal position, either right or left lateral decubitus. If necessary the hospital bed should be used to transport the patient to the x-ray room for study. A simple flat plate made with a portable machine is usually unsatisfactory. Supine horizontal and upright views aid in revealing more occult conditions. Definite evidence of mechanical obstruction such as intra-abdominal masses of recent inflammatory origin may be found and in cases of distention not following surgery a pneumoperitoneum may aid in the diagnosis of a ruptured peptic ulcer.

The roentgenogram of simple adynamic ileus reveals segments of distended bowel usually of uniform size throughout the abdomen. Both the large and small bowel as a rule are involved. Fluoroscopically the intestinal loops frequently contain both gas and fluid and move freely since there is usually no fixation. Repeated examinations unless treatment is instituted show little change in the bowel pattern.

Whenever possible adynamic ileus must be differentiated from me-

chanical obstruction and from ileus associated with peritonitis or localized intra abdominal lesions. In mechanical obstruction there are large loops of distended bowel up to the point of the obstruction. Fluid levels are seen in the upright or lateral views. On auscultation there is evidence of accentuated peristalsis. A high obstruction involving the jejunum or upper ileum finds the distended bowel lying horizontally in the so called stepladder arrangement. The circular folds of the valvulae conniventes of the jejunum usually are not obliterated by the distention. These markings cause difficulty in distinguishing the jejunum from the colon particularly when the colon is contracted or when there is great distention in the jejunum. Obstruction of the lower ileum usually shows the distended loops lying more in the right lower side of the abdomen. The loops are smooth walled and tend to arrange themselves in a more vertical direction.

When paralytic ileus is an exhibition of intra abdominal inflammation a more complex picture is presented. Levitan¹³ has emphasized the difficulty in differentiating early localized peritonitis with adjacent loops of distended bowel from mechanical obstruction. If the peritonitis spreads more loops of both large and small bowel will be distended with gas and fluid as in cases of nonperitonitic ileus. The free fluid in the abdomen increases the shadow between the loops of bowel. The markings in the bowel and between the visceral and parietal peritoneum along the lateral wall are largely obliterated.

Combinations of both mechanical and paralytic obstruction may occur. These patients require repeated clinical laboratory and roentgenologic examinations. An undiagnosed and untreated strangulating mechanical obstruction may progress to necrosis with peritonitis and a superimposed paralytic ileus. Conversely Wangenstein⁵ states that in inflammatory lesions in which the obstructing element is conspicuous it may be impossible to distinguish whether a strangulating obstruction alone exists or whether an inflammatory lesion complicated by simple obstruction is present.

LABORATORY EXAMINATIONS

All tests of the urine and blood must be carefully considered in the light of the history and clinical examination. If vomiting is predominant the *urine reaction* is always alkaline. The urine is usually decreased in amount and concentrated. A *specific gravity* above 1.030 indicates marked dehydration and if it is below 1.010 incompetence of the kidneys should be suspected. The finding of *sugar* may uncover an unsuspected diabetic coma since the onset of nausea and vomiting may suggest an abdominal disorder. Traces of *albumin* are common especially if the patient is febrile. The *urinary sediment* may give indication of a urinary tract infection or a grave disorder of the kidneys. Changes in the blood picture from day to day may give more true information than the original determinations. The *hematocrit*

may be increased up to 15 per cent though it will vary from person to the next so that subsequent determinations will show directional changes in hemoconcentration. The red blood cell count and hemoglobin percentage likewise will show normal or even elevated levels. Frequently the predominance of hypochromic red cells in the smear is the only indication of anemia. The leukocyte count is important as an indicator of the degree of infection though frequently it is normal in overwhelming infection. In the latter instance some reliance must be placed on the finding of a shift to the left of the Schilling index. Hemorrhage, dehydration and trauma may produce leukocytosis in the absence of infection.

Plasma chloride determinations are extremely important when related with the plasma protein determinations and the nutritional state of the patient. Frequently the latter can be determined only from the history. Readings may vary from a low in the neighborhood of 300 mg per cent to a normal of 580 to 600 mg per cent (50-96-100 milli equivalents per liter). The more pronounced the vomiting the greater the degree of hypochloremia. The same effect is produced by constant gastric suction.

The carbon dioxide combining power of the blood is increased in the presence of alkalosis and hypochloremia. This condition may be produced by vomiting or by constant intragastric suction. The alkalosis usually will not occur if there is adequate urinary output, when vomiting occurs the kidney excretes an alkaline urine containing sodium bicarbonate. If vomiting persists however Peters¹⁹ has shown that there will be a time when the body will no longer permit the loss of sodium from the urine and in the final stage there will be acid urine, dehydration, alkalosis, salt depletion and reduction of osmotic pressure all combined.

Plasma protein determinations are frequently misleading. Since serum albumin fraction is almost solely affected in starvation and plasma loss it is necessary to determine only the total protein and disregard the albumin globulin ratio or globulin fraction. Preoperative determinations are of more value than those taken during the disturbances brought about by severe distention. A history of reduced caloric intake both qualitatively and quantitatively and repeated low plasma protein determinations are an indication of a serious depletion of both the total plasma protein and the tissue protein. Determinations between 5 and 6 gm per cent are found to be abnormally low. Some variation in values is observed between bed and ambulant patients. Total circulating plasma volume determinations (and frequently determinations of the available extracellular fluid) have not yet become routine procedures. These are at present the best indicators of the effects of distention. Both mechanical and simple distention of the small intestine in dogs and human beings reduces the total plasma volume. At the same time there is little change

in the plasma protein percentage and the hematocrit or hemoglobin may be increased Evans⁹ showed that in dogs there was enough plasma loss locally from the segment of distended bowel to account for the loss of plasma volume. This has not been demonstrated in human beings though in prolonged distention there may be large quantities of free fluid containing proteins in the peritoneal cavity. In peritonitis the copious exudate and transudate containing proteins would seem to be correlated rather directly with the decrease in total circulating plasma proteins. Peripheral circulatory collapse occurs when the vasoconstrictor mechanism of the vascular system ceases to be effective because of great disparity between the blood volume and the vascular bed. Therefore as Evans,⁹ Abbott, Mellors and Muntwyler, Fine, Hurwitz and Mark¹⁰ and others have shown the plasma protein percentage and the hemoglobin or hematocrit are of no value in determining the plasma volume but rather of value only in indicating direction of change.

DIFFERENTIAL DIAGNOSIS

The recognition of adynamic ileus is not difficult. Since the condition as I have said before is not a disease entity but rather a condition brought about by a specific pathologic process or disturbed physiologic function the determination of the underlying cause is the diagnostic problem.

Mild or severe distention with or without vomiting and with little abdominal pain is as a rule a reflex inhibitive ileus and is seen most commonly in the postoperative state. Vomiting, distention, unlocalized and colicky abdominal pain indicate a simple mechanical obstruction. Vomiting, distention, waves of severe colic and definite tenderness and rigidity of the abdominal wall indicate a strangulating obstruction but in this picture a variety of conditions must be ruled out: stone colics of the biliary and urinary tract, twisted cyst and tumor pedicles, pancreatitis, peritoneal inflammations (general and localized), retroperitoneal hemorrhage and purpura with bowel hemorrhages and finally uremia, diabetic coma, and rarely tabetic crisis.

There are few times in surgery when greater diagnostic acumen is needed. The history, physical examination, laboratory and roentgenologic studies must be evaluated carefully and frequently enhanced in value by repetition. During the observation period small intestinal intubation must be carried out if possible. It must be decided whether the obstruction is strangulating and therefore surgical or whether the condition is inflammatory with a marked obstructing element. We have been in accord with Wangenstein⁵ who firmly believes that conservative treatment with release of the distention by intubation and suction in the inflammatory condition presenting obstruction is safer for the patient than operative intervention.

TREATMENT

The chief weapon in combating distention is the application of suction to an indwelling tube in the stomach or small intestine. The effect of suction on the chemical and fluid balance at different points of the gastro intestinal tract must be known. This effect must be regulated by proper fluid and electrolyte replacement. Methods of obtaining nutrition must be employed if suction is prolonged. Methods which will aid decompression by suction or which may be used if intubation is unsuccessful must be applied in special instances.

Decompression by Intubation and Suction—Immediate intubation with suction in massive postoperative ileus will bring dramatic improvement. In many instances it is not necessary or possible to intubate the tube far into the small intestine. Successful decompression is possible because the distention is uniform throughout the intestine. It has not persisted long enough for acute intestinal angulation. Multiple partially closed loop obstructions to develop. In addition, the bowel has not lost much of its ability to contract.

If the distention is of long duration the introduction of the tube is difficult and decompression of the intestine is accomplished in stages. The segments of the bowel must be decompressed successively as which the tube advances only as rapidly as the muscle tone and peristalsis of contractility return. Thus it is easy to understand why it may take five days sometimes are required for the balloon tip to reach the terminal ileum. Bisgard Matson and Hirschmann⁸ checked kymograph recordings of the pressure exerted on an inflated bulb introduced into the bowel lumen in peritonitis. In an advanced case the bowel had no contractility. In another patient who recovered it was found after decompression before the bowel resumed contractility.

The general acceptance of conservative suction decompression of intestinal distention by use of the indwelling duodenal tube was given its first great impetus by the reports of Wangensteen in 1931 and 1933. Also in 1933 Paine and Wangensteen¹⁸ showed conclusively that the removal of gastric and duodenal contents by siphonage through an intubing duodenal tube was ineffectual when continued with constant suction. The entry of gas into the siphon interrupted action and siphonage can occur spontaneously again only when gas accumulates in the stomach under sufficient pressure to force it out. The introduction of the double lumen balloon tipped tube by Miller and Abbott¹⁹ in 1934 and the extension of its usefulness by the reports of Abbott and Johnston⁴ in 1938 and Abbott³ in 1939 have established it as the tube of choice. If this type of tube is not available or if a smaller tube is necessary because of nasal obstruction the distention usually will respond equally well to an intragastric duodenal or upper jejunal tube if used early. However the Miller-Abbott tube should be used whenever possible because of its ability to reach the distal jejunum and ileum.

Methods of Intubation—In apprehensive patients or in those in whom one has been unable to insert the balloon tip through either nostril ephedrine or a topical anesthetic should be sprayed into the nose. A solution of 1 per cent ephedrine in saline or a 2 per cent cocaine solution is effective. The latter in addition to shrinking the turbinates has an anesthetic effect. The tube tip is lubricated, the patient is given a mouthful of water and instructed to hold it until the tip is felt back in the pharynx. At this point the patient swallows and the tube easily enters the esophagus. Swallowing is then continued as the tube is introduced, water being taken through a glass drinking tube. The tip of the tube is advanced until it lies at the pylorus having followed the greater curvature of the stomach. At this point the stomach should be aspirated of all retained fluids and gas and the suction shut off.

The patient is then turned on the right side and given a glass of water to sip slowly. He is then moved to the x ray room for fluoroscopic examination. By this time the tip of the tube may have passed through the pylorus. Aspiration of bile may be an indication of success. When the tip is in the third portion of the duodenum the balloon (previously tested for size and leaks) should be inflated with 20 to 30 cc of air. Peristalsis should then move the balloon along through the intestine.

The suction apparatus is then turned on again. This is most important for frequent observation of the progress of the tube. The tube is advanced slowly by the patient or physician or is allowed to progress of its own accord. More important is the frequent irrigation of the tube to assure its patency to aspirate the intestinal contents and successfully deflate the bowel. In the absence of peristalsis advancement of the tube should not be more than 3 or 4 inches every hour. More ambitious advancement of the tube by the patient or physician usually will result in its coiling in the stomach. Progress should be checked frequently by fluoroscopic examination or films.

This procedure will accomplish intubation of the small intestine in about 50 per cent of the attempts. When intubation is extremely difficult or seems impossible the greatest amount of patience and attention to detail are required. Various methods should be tried. Matheny and Hutchins¹⁴ reported a high percentage of success by placing the patient in the right Sims position with the foot of the bed elevated 10 inches when the tube had been advanced to the 60 mark. The patient is then given 2 quarts of warm water to drink in the next two hours while the suction is on. The tube is allowed to move to the 75 mark and the patient then drinks another quart of water and is taken to the x ray machine. The tube tip usually is found in the third portion of the duodenum. The bulb is then inflated.

In 1941 Abbott³ described the use of a wire stilet introduced into the side of the tube about 3 feet from the balloon and following the

lumen of the tube to the first perforations. A bend in the wire at the point of introduction will prevent its advancing into the lumen when it is used. The tube then is manipulated under the fluoroscope and frequently immediate intubation of the duodenum can be accomplished. Again the success of the method rests primarily on the persistence of the operator.

Intestinal or intragastric intubation suction for prophylaxis of postoperative distention is not practiced routinely in the Lahey Clinic. Its use is limited to a few types of cases mainly patients with early ruptured appendix or perforated ulcer resections of the small bowel, some of the subtotal gastric resections and following repair of large ventral hernias. Previously I have emphasized that the routine use of spinal anesthesia in place of inhalation anesthesia has been the main factor in reducing our incidence of distention. Gentle handling of the abdominal contents and reduction of operation time to competent minimums also aids in preventing postoperative distention. We do not routinely employ suction after resection of the terminal ileum, right colon or rectum. Singleton⁴ and co workers used it routinely in over 500 abdominal cases. They found that it prevented postoperative distention and vomiting and that there was an earlier return of peristalsis. It favorably influenced wound healing and seemed to lower morbidity and mortality.

In limiting the use of prophylactic postoperative suction the majority of abdominal patients are spared loss of fluid and electrolytes from the stomach and the more significant loss of bile and pancreatic fluids if the tube is in the duodenum or jejunum. We have avoided the discomforts to the patient and the expenditure of extra time and effort needed to carry out the suction properly. Postoperative gastric dilatation and distention are important since the stomach acts as the pacemaker for the intestinal tract. Fortunately it recognizes it is easily corrected with the suction applied to a simple Levin or Wangenstein tube. Coordinated gastric and intestinal motility usually will follow decompression. Therefore one must assay the whole picture of early distention and decide whether the simple intragastric suction will suffice or whether immediate intubation with a Miller Abbott tube is indicated. In prolonged use of a Miller Abbott tube in the lower reaches of the intestine it is frequently necessary to use intragastric suction also for short periods when gastric distention occurs. One should not hesitate to intubate through the other nostril to deflate and lavage the stomach. It is unreasonable to expect that a Miller Abbott tube in the lower reaches of the intestine will be able to decompress the stomach.

Suction Apparatus—Suction apparatus needs little discussion since everyone is familiar with the systems in use today. It is essential to use three one gallon bottles. The third bottle is used as a trap to collect and measure the aspirated fluid while the aspirated gas passes

through the tube to the top of the inverted bottle. It is essential to have a Y connection between the trip and the patient so that the tube can be irrigated frequently while the suction is clamped off momentarily. If the tube tends to plug with mucus warm bicarbonate of soda is more efficacious than water for irrigation. When the suction is shut off for increasing lengths of time to determine the ability of the bowel to handle fluids the clamp should be within reach of the patient so that it may be turned on again if there is a recurrence of distress and distention.

Tube and nasal hygiene are important for the comfort and cooperation of the patient. If the tube is at the desired level it should be attached by adhesive strips only to the nose rather than by adhesive strips across the face. The latter irritate the patient and he is unable to wash his face or be shaved. A bland nasal oil should be used in the nose several times a day. If the tube is to remain in for a long period it should be withdrawn for a distance of 4 or 5 inches every day or two and the tenacious nasal mucus should be wiped off with a solvent solution.

The patient's clinical progress and his ability to retain fluids without distress when the suction is turned off should determine how long the tube is left in place. In simple postoperative distention the tube can be withdrawn after thirty six to forty eight hours. In peritonitis it may be several weeks before the bowel regains sufficient contractile and absorptive power to allow cessation of suction. A marked decrease in the amount of drainage is a good indication of improvement.

Drugs and Other Measures Which Aid Suction Decompression — Drugs have a definite value in the treatment of distention. Their lack of general acceptance has been due largely to injudicious use and an incomplete knowledge of their actions. They should never be used in distention if one suspects the viability of the bowel or a mechanical obstruction. It must be understood that morphine, physostigmine and prostigmine can produce vigorous contractions in the small bowel and that posterior pituitary extract and pitressin produce vigorous stimulation of the colon. Further there is a contrary action between the large and small bowel and a drug stimulating one as a rule will inhibit the other.

Puestow¹ showed these facts to be true in a two year hospital study on a patient with an exteriorized right colon and a visible small bowel. Schwartz, Reingold and Necheles² showed also in dogs that prostigmine causes contractions in the small bowel after paralysis of the parasympathetic nerve endings thus indicating its direct action on the intestinal musculature. We have found prostigmine to be effective in ileus due to peritonitis or in prolonged ileus secondary to other intra abdominal infections. It is given in ampules of 1:4000 (or 1:2000 in patients weighing over 60 kg) every four to eight hours.

This is most effective when the condition is stationary and when recovery begins. Motility of the small bowel is definitely encouraged.

The prolonged use of morphine usually results in distention of the colon. A rectal tube or enemas (if there is no peritonitis) frequently bring about evacuation. This may be supplemented by small doses of *pitressin*. We have seen excellent results from the administration of 5 minims of *pitressin* every thirty to sixty minutes for two to four doses and have observed no ill effects. A rectal tube always should be inserted when the injections are given to allow immediate release of gas. In patients with prolonged ileus a combination of both drugs often is necessary. If morphine is not being used and thus the action of the colon is not inhibited the use of prostigmine frequently will cause evacuations because of the large amount of small intestinal content emptied into the colon. Simple postoperative distention in which nasal intubation has not been necessary usually will respond well to these drugs. In the first one or two postoperative days prostigmine is the most effective, *pitressin* being reserved for the distentions of the colon appearing after the second or third day.

Heat applied to the abdomen is a time tested adjuvant in the treatment of distention. Its effectiveness in giving relief from cramps is immediately noted and patients welcome its application. It diminishes the motor activity of the intestinal tract. In a study of thermal responses of the intestinal tract Bisgard Matson and Hirschmann³ concluded that the application of heat to the abdominal wall related segments in marked spasm and thereby permitted a more coordinated intestinal activity. The application of cold stimulated peristalsis. The ingestion of hot and cold fluids reversed the responses.

The breathing of 95 per cent pure oxygen has been suggested by Fine and co workers. It was shown to reduce the gas volume within the intestine when given continuously or intermittently for twelve to twenty four hours. Paine, Keys and Lynn¹⁷ produced pulmonary congestion and liver and heart changes in dogs confined to concentrated oxygen over prolonged periods. Our own experience with oxygen therapy is limited to the use of the oxygen tent for the relief of respiratory distress in massive distention and for the daily use of patients with peritonitis and distention. These low concentrations probably have no effect on the distention but they reduce the burden of the heart and respiration in the seriously ill patients and should be used freely.

Spinal anesthesia has a limited place in the treatment of distention not secondary to intra abdominal infection. If intubation is unsuccessful in simple inhibitive distention spinal anesthesia may bring about intestinal contractions and evacuations. The effect is not prolonged and there is no harm in the procedure. Symptomatic relief is usually striking. This treatment may be combined with small doses of the drugs which stimulate the small and large bowel. Novocain block of

the splanchnic nerves will produce the same effect but should be bilateral

Fluids and Electrolytes—The dehydration and hypochloremia accompanying intestinal distention require study of the patient's nutritional state previous to operation or the disease producing the distention. The presence of a low initial plasma protein further reduced by the distention is a paramount factor in the development of edema when salt is administered. Sepsis with profuse loss of protein and kidney damage further contribute to the production of edema. It is impossible to raise the chloride level to normal in these instances. The fluid and salt administered usually is deposited in the tissue. This fact was shown by Powers, Pederson and Maddock⁶ who studied a series of patients to check the fluid and electrolyte replacement rules previously stated by Collier and Maddock.⁷ The rule is: To maintain the normal sodium chloride level while abnormal gastrointestinal fluid losses are occurring, give a volume of Ringer's or physiologic saline solution equal to the volume of gastrointestinal fluid lost. If gastrointestinal suction drainage is instituted, 1 000 cc of Ringer's solution should be given during the first day to prevent an initial depletion of body electrolytes. Thereafter, follow the volume for volume replacement, but a minimum of 500 cc of Ringer's solution should be given each day of such drainage, although the gastrointestinal fluid loss may be less than that amount.

Fluids therefore consist of normal saline in an amount equal to the loss by suction with an additional liter given the first day. The rest of the fluid from 1 500 to 3 000 cc daily should be given as distilled water with 5 or 10 per cent dextrose. Sweating and the weight and age of the patient are other factors which must be considered. A patient who is putting out 800 cc or more of urine each day is in good fluid balance.

It is a mistake to allow patients to drink freely while the intragastric or duodenal suction is in operation. We allow only sips of water or other clear liquids to keep the feeling of dryness and thirst under control. Peters¹⁹ has shown so well the effects of indiscriminate water intake which is soon lost by suction or vomiting. As the water enters the stomach or intestine it tends to assume a composition native to the viscera. Salt is poured in to make it isotonic. If this fluid is lost the chloride level of the blood will fall and in the interest of acid base equilibrium the kidneys will excrete an equal amount of urine containing bicarbonate. The administration of water by mouth under these circumstances paradoxically becomes a dehydration measure. Patients could drink physiologic saline freely and prevent this vicious cycle, but our experience is that they object to the taste and to the fact that it is not refreshing.

Intravenous Alimentation—The maintenance of the patient's nutrition depends on three factors: (1) the intake of adequate amounts of

dextrose to supply needed caloric requirements and spare body proteins (2) an adequate supply of amino acids to continue a positive nitrogen balance if possible and (3) whole blood for the correction of anemia and plasma if there is a low volume of circulating plasma or a constant loss of protein exudate as in prolonged distention or peritonitis

1 If 10 per cent dextrose is used from 800 to 1200 calories can be given in twenty four hours. If less than this amount is given the amino acids and even the plasma are utilized by the body as simple energy calories. Thus the carbohydrate must be given to spare the proteins. In weak or debilitated patients the rate of flow must be carefully controlled since a rise in pulse and even cardiac embarrassment will easily occur. Subcutaneous administration of 5 per cent dextrose in water is sometimes the only way fluid may be taken without danger since the rate of absorption is extremely slow.

2 Early investigators in the field of intravenous protein administration had hopes of raising the serum protein levels. This rarely can be accomplished and never can be accomplished in patients with distention and its associated protein loss. Sacher, Horvitz and Elman have shown that to raise the total circulating plasma protein even 1 gm. the tissue proteins must be raised by many times that much (perhaps in the neighborhood of 25 to 30 gm.) and to raise the total protein by 1 per cent would require nearly 2000 gm. of protein to be taken into the body and utilized. What can be accomplished by giving amino acids is the prevention of any further nitrogen loss. For most of the patients Brunschwig, Clark and Corbin⁸ showed that any major surgical procedure produced a net loss of nitrogen in the first ten days. They were able to maintain or in some cases gain, a positive nitrogen balance by the intravenous administration of amino acids.

We administer from 200 to 300 cc. of 15 per cent amino acid solution (30 to 45 gm.) each twenty four hours. This is given with the intravenous fluids. If given slowly untoward reactions are rare. Complete details of administration are given in an article entitled "Amino Acid Therapy in the Hypoproteinemic Surgical Patient" in the June 1943 issue of *Surgical Clinics of North America* (Farrs and Boehme).

3 Large transfusions of whole blood should be administered if there is evidence of anemia or small repeated transfusions of fresh blood if there is severe infection associated with distention. Plasma is necessary if the loss is continuous or when the plasma volumes are low and circulatory collapse is threatened. Plasma should rarely be given to supply nutrition. A half pint plasma infusion contains only 17 g. of protein and 2.8 gm. of nitrogen. The expense rarely justifies its constant use for nutrition alone. In extremely debilitated patients, or in those with a continuing loss of plasma it is a lifesaving measure to

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be used while the underlying cause of the distention is brought under control

At this point it is well to emphasize that the oral intake of protein and carbohydrate is far superior to intravenous feeding. Thus in patients with the tube low in the small intestine feeding should be carried out. A diet fairly well tolerated should consist of all clear nourishing liquids including strained fruit juices, junkets, jellies, custards, cream cheese, rice, macaroni, spaghetti, well pureed vegetables, finely ground meat, raw or boiled eggs, and toast. If the stomach tolerates only small amounts, liquids fortified with Mead's Nutramagen will furnish a high caloric value of readily digestible carbohydrates fortified with amino acids. As previously mentioned, gastric lavage or suction may be necessary when the tube is low in the intestine. This should not discourage the oral intake of food. Smaller amounts and a more carefully selected diet should be taken.

In ileus associated with infection, sulfonamides are frequently administered intravenously in the form of sodium sulfadiazine dissolved in distilled water. The usual precautions of sulfonamide therapy must be observed while a satisfactory blood level is maintained. Vitamin C (500 to 1000 mg) and thiamin chloride (50 to 100 mg) should be given in daily intravenous doses. Liver extract and vitamin B complex given intramuscularly may also be of value.

SUMMARY

It is emphasized that adynamic ileus is a syndrome which is secondary to some other serious pathologic condition or disturbed physiologic function and should not be regarded as a separate disease. The distention requires prompt treatment because if prolonged it produces systemic changes which endanger the life of the patient. The treatment of choice in early postoperative or other nonperitonitic distentions is suction applied to an intragastric or intraduodenal tube. In peritonitic and other prolonged distentions, suction should be applied to a tube which is able to reach the lower small intestine. The tube of choice is the Miller Abbott balloon tipped double lumen tube. Proper use of drugs and other measures aid in the relief of distention and their use is encouraged. The correction of fluid and electrolyte loss and the maintenance of nutrition are second in importance to decompression of the gastrointestinal tract.

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MEDIASTINITIS AS A COMPLICATION OF ESOPHAGOSCOPY AND INSTRUMENTATION OF THE ESOPHAGUS

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THE diseased esophagus is a vulnerable and vital organ through which even the careful passage of a bougie or examining instrument or esophagoscope may be followed by the lethal complication, mediastinitis. Even when the esophageal wall is normal it may be traumatized so that infection within the always septic lumen may pass through its walls and produce mediastinitis. Thus to prevent tragedy esophageal instrumentation must be carried out with the utmost caution and respect for this vulnerable organ. Only after careful diagnostic studies including the clinical history, general physical examination, examination of the neck, indirect laryngoscopy and the appropriate roentgenologic examinations with both plate and fluoroscopy with and without suitable opaque mixtures in all positions should esophagoscopy be done. Also if esophagoscopy is contemplated roentgenograms should be made to visualize the cervical vertebrae and any spurs on the anterior surface should be noted.

Having obtained all available information one is forewarned and may avoid tragedy, that is trauma or perforation with resultant mediastinitis.

Fatal mediastinitis may occur without instrumentation from esophagitis, burns with caustic solutions, and rupture of the esophagus associated with infection and vomiting. Vinson recorded a case in which the patient drank water using unusual force to get a bolus of meat through an old live stricture of the esophagus with resultant perforation and death.

The esophagus may be perforated when a sharp or pointed foreign body is swallowed or during its removal. I observed a woman with upper and lower dentures who had swallowed a sharp chip of glass. She regurgitated the piece of glass immediately without instrumentation but in the process the glass cut an opening through the esophageal wall $\frac{1}{4}$ inch in length through which a large amount of air, food and fluid passed into the cervical region and upper mediastinum. Even though immediate mediastinotomy with closure of the rent in the esophagus was performed with at first an apparently satisfactory convalescence the patient died eight days later from massive hemorrhage from erosion of a large vessel in the upper mediastinum.

I have seen a number of patients in whom a foreign body was present in the hypopharynx and upper esophagus for a number of days, and the wall of the esophagus or pharynx was perforated with abscess formation and induration in the neck. In such cases drainage of

the abscess takes place along the foreign body through the perforation into the esophageal or pharyngeal lumen and in many cases extraction of the foreign body is followed by resolution. In a few cases however the infection spreads and external surgical drainage should not be withheld.

The surgeon who performs the esophagoscopy should work in close cooperation with the thoracic surgeon since drainage of the thoracic mediastinum lies well within his field.

In my personal experience in the last sixteen years mediastinitis has occurred in 8 patients as a result of instrumentation.

One patient had a carcinoma at the level of the web in the mid third of the esophagus and a second carcinoma in the lower third. In passing the web and the upper cancer the membrane was torn with resulting infection and the patient died of mediastinitis seven days later after gastrostomy and supportive treatment. In inoperable carcinoma such heroic treatment as a mediastinotomy is not justified.

In 7 patients mediastinitis resulted from pressure of the esophagoscope on an exostosis or a spur protruding anteriorly from the cervical vertebrae (Fig. 279). These spurs may be of such length that they press on the esophagus and Mosher¹ says they can be so sharp as to pierce the esophagus and cause bleeding. In both cases the trauma was not known to have been inflicted at the time of the esophagoscopy and in all probability did not occur when the instrument passed through this area but occurred on visualization of the extreme lower end of the esophagus and cardia of the stomach. It is in this position that the head is most extended and no doubt the pressure from the upper portion of the esophagoscope impinged upon the spur of the vertebrae. This caused trauma or perforation sufficient to allow bacterial invasion.

Both of these patients had a mediastinotomy. The first patient who was seen before chemotherapy was used did very well for three weeks. Cure seemed certain when an osteomyelitis developed in the vertebrae in which the tip of the sharp spur was broken. In spite of attempts at drainage of the osteomyelitis he developed meningitis and died. The second patient had both a cervical and posterior thoracic mediastinotomy and is making a satisfactory recovery. However her condition was grave for two weeks. She received the sulfa drugs and penicillin and otherwise would not have survived.

In 1 patient a complete stricture of the esophagus resulted from drinking varnish by mistake. This man was unable to take even liquids for two weeks and was kept on clysis and intravenous solutions. Gastrostomy was advised and insisted upon for two days but both he and his wife had been told that he could be treated with the esophagoscope and refused any other procedure until esophageal dilatation had been tried.

On esophagoscopy the area in the middle third of the esophagus

where the lumen had been was easily identified and filled with granulation. The small sizes of Jackson dilators passed readily and apparently without untoward effect. Following the dilatation a swallow of water caused definite substernal and epigastric pain. From this symptom alone esophageal perforation seemed certain and the thoracic surgeon was called into consultation and sulfa therapy was begun but due to the patient's obstinacy and the absence of further symp-

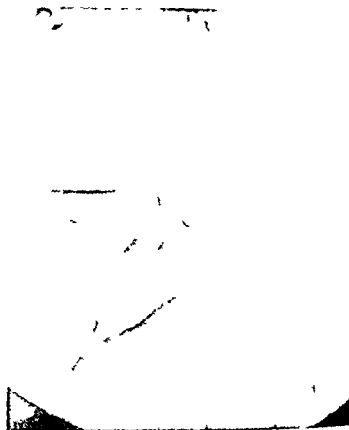


Fig. 9—Lateral esophagram showing the lower cervical and upper thoracic midistinum with the trachea pushed forward and gas in the area between the trachea and the vertebrae. Esophageal perforation in this instance secondary to spur on the anterior surface of the cervical vertebrae.

toms mediastinotomy was not performed until two days later when definite symptoms had developed and the family was convinced that to delay operation would be fatal.

A posterior mediastinotomy was carried out draining a well developed mediastinitis. Eight days later a gastrostomy was performed, followed later by retrograde esophagoscopy and bougies passed a thread through the stricture. Retrograde dilatations were carried out by the Tuohet method. The patient made a complete recovery.

It is my belief that sulfa drug therapy and penicillin will decrease the incidence and spread of such an infection but will not supplant surgical drainage. All physicians who have had experience with such esophageal strictures recognize that instrumentation is a dangerous procedure especially after stricture formation with complete obstruction. If such a patient is given a thread to swallow before the stricture becomes complete or retrograde dilatation is carried out through a gastrostomy, mediastinitis can be prevented. In the case described one might well have let the patient suffer until he was agreeable to accept advice or go elsewhere for treatment.

In 3 patients dilatation of the esophagus was followed by mediastinitis. In the first patient, who had a cardiospasm, the esophageal wall was injured by the introduction of the instrument through the narrowed area. This was my first patient to die of mediastinitis (1950). Lower thoracic mediastinotomy had not been developed. In the second patient, cervical mediastinotomy was carried out thirty-six hours after dilatation and a complete recovery took place in two weeks. In the third patient death occurred following a cervical mediastinotomy which was performed within three hours after perforation.

In 1931 a patient died following perforation of the cervical esophagus from faulty technic in the passage of the esophagoscope. Mediastinotomy was done on the first day after perforation.

Of real interest 2 patients had chills and fever following esophageal dilatation of a fibrous stricture of the upper esophagus without developing mediastinitis or other outward signs or symptoms. The chills and fever were comparable to symptoms after urethral dilatation.

One patient with cardiospasm who had had numerous episodes of chills and fever had been treated for malaria. These symptoms were from the absorption of sepsis in the esophagus and occurred without manipulation.

Two patients with complete stricture of the cervical esophagus in whom a portion of the esophagus had been removed by mistake at the time of thyroid operation have been referred to me for treatment. Both had septic wounds and one had had repeated abscesses. Neither had developed a spreading mediastinitis. Incidentally, both patients are now taking a normal diet. Certainly these 2 cases seem a reasonable argument for early open drainage of an esophageal perforation.

In 3 of the 8 cases instrumentation was followed immediately by severe pain in the lower neck, substernal area or upper epigastrium which persisted and was made worse by swallowing. Severe pain in these areas or in the back after vomiting or instrumentation of the esophagus should be considered evidence of perforation or rupture of the esophagus.

Roentgenologic studies of the mediastinum showing gas or air in the tissues widening of the mediastinum and anterior displacement of the trachea or thickening of the tissues between the trachea and vertebrae of the cervical region are definite evidence of mediastinal involvement. In the patients in whom the perforation was due to pressure over the cervical vertebral spurs symptoms came on slowly becoming progressively worse and were not recognized as of importance for forty eight to seventy two hours after instrumentation had taken place with increased symptoms. Pain soreness of the neck and dysphagia were accompanied by fever an increase in white blood cell count and positive roentgenologic findings.

SUMMARY AND CONCLUSIONS

In localized mediastinal or esophageal infection which is drained about the perforating foreign body and has been present for some days extraction of the foreign body fluids and sulfa therapy under careful observation will result in a large percentage of cure but if at any time further spread of the infection is evident by the patient's symptoms blood studies or roentgenologic examination, surgical drainage of the mediastinum should be carried out.

In the extraction of a fine pointed foreign body such as a safety pin the point of the pin may pierce the mucous membrane or wall. Under careful observation and medical treatment many will recover without mediastinitis yet should symptoms develop surgery must not be delayed.

In rupture of the esophagus from any cause mediastinotomy with open drainage should be carried out immediately and all necessary supportive treatment given with sulfa drugs and penicillin. A mediastinotomy should be performed as soon as mediastinitis is diagnosed following any instrumentation.

Instrumentation of the esophagus should be preceded by careful study of the patient fluoroscopically and roentgenologic examination of the esophagus and of the cervical vertebrae. It is then to be undertaken with caution as fatal mediastinitis which fortunately is a fairly rare complication may result.

My experience with 8 cases of mediastinitis secondary to esophageal instrumentation is outlined. The symptoms and diagnostic findings are described.

Open drainage of the mediastinum is advocated for any rupture of the esophagus perforation or mediastinitis as soon as diagnosed except localized mediastinitis or para esophageal abscess which is draining into the pharynx of the esophageal lumen.

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SPLENECTOMY ITS INDICATIONS AND COMPLICATIONS

JOHN W NORCROSS

ALTHOUGH considerable is known about the spleen it still remains in many respects an organ of mystery for its functions are only partially understood. In embryonic life it is an important seat of formation of all types of blood cells while in adult life only lymphocytes and monocytes normally arise there. Under unusual circumstances as in profound anemia and agnogenic myeloid metaplasia other blood cells are formed in the mature spleen. Following hemorrhage the splenic capsule is able to contract and expel a small reservoir of blood into the general circulation. As an important part of the reticulo-endothelial system it has certain phagocytic functions and is thought to play a role in the elaboration of immune bodies. In its sinuses senile and abnormal erythrocytes and other blood cells are destroyed. Much evidence points to a careful balance between factors tending to accelerate the formation of blood cells in the bone marrow and an inhibiting or restraining influence of the spleen on hematopoiesis. Banti suggested a theory whereby the congested fibrotic spleen in some indirect manner may cause cirrhotic changes in the liver. This interesting idea never has been proved or satisfactorily disproved. This organ also may be associated with the normal maturation of erythrocytes and probably is associated with the metabolism of lipoids and pigment.

In the normal human being splenectomy frequently causes a low grade transient anemia which is usually of short duration and may occasionally be followed by a mild polycythemia. A leukocytosis of 75,000 or even slightly higher and a thrombocytosis regularly follow this surgical procedure and may persist for many months. The erythrocytes show abnormalities of maturation as evidenced by the presence of Howell Jolly bodies, basophilia and target cells. Such changes may persist over a long period of time.

INDICATIONS

Splenectomy usually is considered justified for the following four conditions:

- Idiopathic thrombocytopenic purpura
- Hemolytic anemia of the congenital type
- Primary tumors of the spleen
- Traumatic rupture of the spleen

Other conditions for which splenectomy is not performed so universally are

Largest splenomegaly
 Primary neutrophilic leukemia
 In spleen
 Acquired hemolytic anemia from various causes
 Acute hemolytic anemias
 Certain types of refractory lymphatic leukemia

Splenectomy is never justified in leukemia lymphoma pernicious anemia erythroblastic anemia sickle cell anemia or Gaucher's disease. In agnogenic myeloid metaplasia the spleen again takes on its embryonic function of erythrocytic and leukocytic hematopoiesis because the bone marrow no longer is able to carry out its normal duty. In this case therefore splenectomy is strongly contraindicated as it removes an important source of blood formation and usually will lead rapidly to a fatal conclusion.

In *idiopathic thrombocytopenic purpura* drugs and other toxic substances as a cause of the condition must be ruled out before splenectomy is considered. Many hematologists feel that the bone marrow should be examined and that the megakaryocytes should be normal or increased in number before operation is performed. In the true idiopathic type splenectomy produces immediate improvement in almost every instance and permanent cure in about 75 per cent of cases. Operation preferably should be done between acute attacks but procrastination in severe cases often leads to disaster and some authorities believe that the danger of waiting is greater than that of operation. In such acute crises the operative mortality may be relatively high. The increase in blood platelets is immediate following removal of the spleen. Rarely does the thrombocytosis reach a dangerous level and postoperative thrombosis is rare. Continued thrombopenia and fatal hemorrhage following this procedure have been reported.

Congenital hemolytic anemia responds remarkably well to splenectomy by removing the chief source of spherocytic destruction. Since the prognosis in the congenital and acquired varieties differs so definitely a proper diagnosis must be established before splenectomy is considered. In congenital hemolytic anemia there is often a family history of jaundice or anemia or perhaps even splenectomy but if not the patient himself shows small thick erythrocytes (spherocytes) a decreased resistance to hypotonic saline solution jaundice which is easily seen or may be proved on examination of the blood a reticulocytosis and an increased urobilinogenuria. Because of the great hyperactivity of the bone marrow a low grade polycythemia leukocytosis and thrombocytosis may persist for many months following splenectomy. Immediately after the operation there is real danger of thrombosis occurring and the preventive measures previously suggested are sometimes necessary.

Acquired types of hemolytic anemia have numerous etiologies and as a whole do not respond dramatically to splenectomy. This procedure therefore should be employed only after all other measures have been unsuccessful. The results occasionally are excellent and frequently only fair but complete failure follows all too often.

Some types of *acute hemolytic anemia* respond completely to this operation but results cannot be foretold accurately. The complications are the same as for the congenital type.

Transfusions given before, during or immediately after splenectomy in any type of hemolytic syndrome are dangerous and may precipitate hemolytic crisis because of the strong isoagglutinins present in the recipient's blood.

In patients with *congestive splenomegaly, damaged liver function* frequently presents an added problem and such patients often have hemorrhaged from gastric or esophageal varices. We believe that splenectomy should be performed in these patients unless the liver is damaged to such an extent that the operative risk is overwhelming.

Careful preoperative evaluation of liver function enables the physician to balance the risk against the advantages of splenectomy and also to anticipate complete liver breakdown postoperatively. It is advisable to check the bromsulfalein excretion test, hippuric acid detoxification test, Takata-Ara and cholesterol cephalin flocculation tests, prothrombin time and serum protein. It is rarely wise to operate on a patient with ascites or hypoprothrombinemia persisting after adequate vitamin K therapy or on a nonjaundiced patient with a high percentage of retained bromsulfalein.

Every patient with any demonstrable liver damage should have at least ten to fourteen days of careful preoperative preparation consisting of a high caloric, high protein, high carbohydrate, low fat diet (not more than 10 gm of fat a day) with added vitamins orally and parenterally and crude liver intramuscularly. Large amounts of skim milk and fat free cottage cheese as well as calcium caseinate are excellent sources of protein. Plentiful amounts of vitamin K are needed in patients with hypoprothrombinemia. Postoperatively these measures should be continued. Intravenous plasma and oxygen administration are beneficial in cases of severe liver damage. Skim milk should be administered as soon postoperatively as it can be retained.

COMPLICATIONS

The complications that may arise from splenectomy are dependent to some extent upon the disease for which the operation is performed. If many of these complications are to be anticipated and avoided the correct diagnosis must be established before proceeding with the operation. Hemorrhage, infection and thrombosis may follow any splenectomy.

Hemorrhage may occur during operation particularly in the re-

removal of a large congested spleen when the capsule is torn by accident if the pedicle has not been isolated and carefully tied Meticulous hemostasis of the many small bleeders present in perisplenic adhesions is essential Generalized oozing occurs when hypoprothrombinemia is present This complication arises when there is extensive liver damage as in the cirrhosis of the liver often accompanying congestive splenomegaly Hypoprothrombinemia occurs when the damaged liver is unable to manufacture bile salts of sufficient quantity to allow normal absorption of vitamin K from the intestinal tract or when the liver damage is severe enough to prevent the elaboration of prothrombin from vitamin K In the former case the administration of parenteral vitamin K quickly establishes a normal prothrombin clotting time In the latter abnormality however there is no established form of treatment at present although the recent report of Kinsey¹ that transfusions from donors who have received large doses of vitamin K restore the prothrombin level of a deficient patient may prove of value in the future

Hemorrhage may occur if oozing is not completely stopped at operation or if the ties placed on the splenic artery and vein give way If the latter occurs collapse and death rapidly ensue Occasional hemorrhage from ruptured varices in the stomach or esophagus complicate the postoperative course and may prove fatal

Infection as a complication of splenectomy may occur as after any other operation It often settles in the subphrenic space causing an abscess and requiring drainage The empty splenic bed frequently is the site of serum collection which fosters the growth of bacteria if any are present

Fever may persist for many days and often is caused by serum in blood accumulation which in time is absorbed Fever occurs with postoperative liver failure and is accompanied by stupor jaundice and decreasing urinary output Continued fever particularly if it is usually increasing must always be considered as probably indicative of infection A flat roentgenogram of the abdomen may show as above a fluid level in a subdiaphragmatic abscess cavity and small amount of fluid may collect above the diaphragm in the pleural cavity because of pleural irritation Sudden rises in temperature unless accompanied by obvious infection in the respiratory tract should lead the physician to suspect thrombosis either intra abdominal or in the lower extremities

Thrombosis following splenectomy is fostered by the rapid rise in platelets which begins as soon as the splenic vein is tied and may quickly increase from a normal of 450 000 to as many as 2 000 000 per cubic millimeter The platelet count should be checked frequently and if it reaches a value of over 1 500 000 anticoagulants should be given Heparin by constant intravenous drip in doses of from 10 000 to 20 000 units per day increases the clotting time from a normal

6 to 12 minutes to about 30 minutes which is sufficiently high to prevent intravascular clot formation

While this method if carefully controlled is probably the safest the less cumbersome heparin dicumarol method is preferred by many Under this regimen the patient is given heparin for about the first thirty six hours until the dicumarol can take effect The dosage of the latter anticoagulant must be adjusted each day after the prothrombin level is determined Accurate laboratory facilities are a prerequisite in either method The danger of the prothrombin time falling to a critical level with resulting hemorrhage may prove to be less important in the future when the recently reported method of effectively treating such hypoprothrombinemia with large doses of vitamin K has been given a further trial

Once thrombosis has spread down the splenic vein and into the rest of the portal system all therapy is without avail Prevention must therefore be the goal in this condition Sudden fever abdominal pain and leukocytosis followed by jaundice and abdominal distention indicate disaster

SUMMARY

The well recognized indications for splenectomy are idiopathic thrombocytopenic purpura congenital hemolytic anemia primary tumor of the spleen and traumatic rupture of the spleen

Splenectomy should be performed in congestive splenomegaly unless severe liver damage is present

Complications that may arise in any splenectomy are hemorrhage infection and thrombosis Their prevention and treatment are discussed

The evaluation of liver function and the therapy of the damaged liver are outlined

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TRANSURETHRAL RESECTION FOR VESICAL NECK OBSTRUCTION FOLLOWING ABDOMINOPERINEAL SURGERY

JARI I. TWIRT AND HOWARD A. HOFFMAN

In 1941 one of us (TTE³) reviewed 750 cases of large bowel surgery in order to study the urologic complications following these procedures. It was concluded that urologic complications are most frequent after removal of the rectal portion of the intestinal tract, and further that the most frequent complication is difficulty in emptying the bladder.

This paper is a report of those patients who underwent abdominoperineal resection of the rectum and subsequently required transurethral correction of the bladder neck for urinary obstruction. The study extends through the end of 1943. The mortality of those patients undergoing transurethral surgery relatively soon after the other major procedure was zero.

INCIDENCE

At the end of 1943 our series comprised 833 patients who had undergone removal of the rectum for carcinoma by the Miles or Lahey procedure. Of these 464 (55.7 per cent) were men and 369 (44.3 per cent) were women. An indwelling catheter with the patient on constant drainage was routinely employed for the first ten postoperative days. After removal of the catheter 81 (9.7 per cent) of the 833 patients were unable satisfactorily to empty the bladder. Sixty-five of these patients were men and 16 were women representing 14 per cent of the male group and 4.1 per cent of the female group.

Forty-four of these 81 patients ultimately came to transurethral correction of the bladder neck because of sufficient prostatic enlargement or bladder neck contracture to produce obstructive symptoms when the anatomic relationship or change in innervation became an added factor after removal of the rectum. All the patients who required transurethral resection were men, the oldest being 76 and the youngest 37 (average age 59.7 years) (tabulation).

Nine of these 44 patients (20.4 per cent) presented no symptoms of bladder neck obstruction preoperatively. The rest of the group had symptoms varying from a minimal nocturnal frequency to the most pronounced obstructive symptoms associated with classical prostaticism.

The women who had postoperative difficulty in emptying the bladder were shown by cystometric study⁴ to be suffering from a transitory detrusor paralysis resulting from a surgically disturbed innervation and only 2 of these paralysees were so extensive as to require tidal

for more than two months. Detrusor paralysis from this cause disappears by the time the catheter is removed.

TRANSURETHRAL RESECTION FOLLOWING ABDOMINOPERINEAL SURGERY

Prostatectomy for Carcinoma		Postoperative Difficulty in Voiding After Removal of Catheter		Transurethral Resection	
Total—833		Total—81 (9.7%)		Total—44	
Males	Females	Males	Females	Males	Females
369	369	65	16	44	0
(44.3%)	(44.3%)	(14%)	(41%)		
				Oldest 16 youngest 37 (average 59.7 yrs)	

ETIOLOGY

Proptosis of the rectum allows definite bladder distortion. The bladder loses its posterior support and practically hangs from the bladder down into the hollow of the sacrum. A definite acute angle is formed by the posterior urethra or vesical lip and the floor of the rectum. In many instances the trigone is unable to correct this angle. The detrusor muscle moving about in space so to speak with no support of the base is only weakly effectual. This malposition with minor disturbances in the balance of the autonomic nervous system predisposes to urinary retention. This bladder difficulty is much more frequent and severe in the presence of even the slightest amount of prostatic enlargement and since men in the age group in which proptosis of the rectum is found are frequently in the group having prostatic enlargement many of these patients fall to the care of the urologist. Radiometric studies of these bladders demonstrate such changes as decreased sensory components, increased bladder capacity and decreased intravesical pressure curve.^{3,4} The anatomic and neurogenic factors affecting the bladder often are happily transient; this organ has the faculty of adjusting itself readily to unusual positions and imbalances of innervation. Postoperative retention due to true anatomic obstruction of the bladder neck is often overlooked because at the preoperative rectal examination median lobe enlargement and contraction of the bladder neck cannot be ascertained.

INDICATIONS

The symptoms of urinary tract obstruction and the degree of prostatic enlargement usually can be obtained from the admitting history and

physical examination. If the urologist has not seen the patient prior to consultation for postoperative retention, then a review of the postoperative course is most suggestive.

The patient coming to abdominoperineal surgery has a catheter inserted the night before his operation. This remains inlying and on constant drainage for ten days. After removal of the catheter the bladder is checked for residual urine every six hours and 2 ounces of 0.5 per cent aqueous mercurochrome solution is instilled through the catheter after each check.

If in twenty-four hours the residual urine is not less than 2 ounces the patient is given another trial on an inlying catheter for four or five days. During this time the bladder is irrigated every three hours with 2 per cent boric acid solution or 0.8 per cent sulfanilamide solution through a closed drainage apparatus.

The catheter is then removed and the residuum is checked as before. If a residual urine of more than 2 ounces persists the patient is scheduled for cystoscopy and any bladder neck obstruction is corrected by transurethral methods at the same time. If no mechanical obstruction is found, cystometric studies are carried out to ascertain any neurogenic disorder.

PREOPERATIVE OR POSTOPERATIVE CORRECTION

The question of the optimal time for transurethral resection is frequently raised. We feel that bladder neck correction is best carried out *after* the abdominoperineal surgery for the following reasons:

1. Detrusor paralysis might occur after the Miles or Lahey resection despite adequate bladder neck correction and this situation would require catheterization over a field just recently subjected to endoscopic surgery.

2. The prostate gland undergoes regression in size after abdominoperineal surgery because of destruction of much of the blood supply. If the prostatic operation is carried out after the abdominoperineal resection the patient is not required to remain on the table as long as otherwise.

3. If the transurethral surgery follows the abdominoperineal surgery, the postoperative reaction is less marked since the operative field has been partially walled off by diminution of the lymphatic and vascular system. Less reaction can be anticipated with respect to fever and postoperative shock.

PROCEDURE

The usual technique pursued in transurethral prostatectomy previously has been described in great detail by the senior author and recently in monographs by Barnes¹ and Nesbit.² We would however like to mention some special features relevant to patients who have already had the rectum removed when appearing for transurethral surgery.

A complete medical check-up always is in order since many of these

patients having suffered a malignant disease for some time show various deficiencies. The patient's blood is typed and blood for transfusion is in readiness. Usually the grade of prostatic enlargement by rectum is ascertained from the record of the initial physical examination. If this is not available the description of the gland may be obtained from the operative note made at the time of abdominoperineal surgery. A history of inguinal pain or the presence of an inguinal hernia may be a clue to bladder neck obstruction as discussed by Dr. Carroll D. Goodhope elsewhere in this volume.

Upper urinary tract studies are always carried out preoperatively since a knowledge of renal pattern and function is essential to detect contraindications to surgery, as well as affording insight into the cause of an occasional prolonged convalescence. For this excretion urograms are employed. Such films provide an excellent means of determining renal function, permit an estimate of residual urine on the evacuation film, and eliminate the need of retrograde cystograms to detect the degree of intravesical prostatic encroachment and the presence of diverticula resulting from obstruction.

Cystoscopy is always the final diagnostic procedure. At this time we are prepared with the proper instruments to carry out transurethral prostatectomy. Low spinal anesthesia with pontocaine glucose is used routinely after premedication with morphine and scopolamine. Bilateral vasectomy for the prevention of epididymitis is performed at the outset on all patients over 55. This obviates any pain and prevents retardation of the postoperative course. If there is any difficulty in introducing a No. 30 F. Van Buren sound the resectoscope is not inserted through the urethra but rather an external urethrotomy is done in the perineum and the resection is carried out through this opening. This has been necessary in only 1 case in this particular series.

The absence of the anus in this type of patient precludes the use of three dimensional perception. Ordinarily palpation of the prostate over the resectoscope by a finger in the rectum affords a valuable method of gauging the extent and amount of hyperplasia of the gland. This is easily done with the use of the O'Connor sheath. However when the rectum has been removed, the actual thickness of tissue between the instrument and the finger cannot be estimated by palpation and one must depend on visual perception and a thorough knowledge of the anatomy of the urethra and bladder neck. The circular arrangement of the fibers of the surgical capsule is easily recognized and at this point resection is complete.

In contracture of the bladder neck the amount of tissue to be removed is necessarily small. We have been impressed with the excellent results obtained by correction of slight contracture of the bladder neck after removal of the rectum. Possibly the destruction of the internal sphincter allows the weakened detrusor muscle to empty the bladder more effectually.

SUMMARY

An unselected series of 833 cases of abdominoperineal resection of the rectum is presented. Eighty-one of these patients had postoperative difficulty in emptying the bladder after coming off catheter drainage.

Persistent symptoms sufficient to require transurethral resection of the bladder neck occurred in 44 patients, all of whom were men. Transurethral surgery was performed between fourteen and forty-six days following the abdominoperineal procedure. The mortality was zero.

The indications for the operation are presented and the optimum time for performing it is discussed.

Finally, the special problems relating to transurethral surgery in patients from whom the rectum has been removed are discussed.

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DENTAL INFECTION IN ADDISON'S DISEASE

(Treatment with Penicillin)

ELMER C. BARTELS AND STEWART H. JONES

THE serious consequences of infection in patients with Addison's disease were emphasized by Rowntree and Snell⁹ and have since been well recognized. Unfortunately the successful control of Addison's disease by desoxycorticosterone acetate has not altered the susceptibility of these patients to infection. Even a minor throat infection may become fulminating or overwhelming and quickly lead to rapid prostration, crisis and death. Death may occur before any appreciable change is noted in the electrolytes of the blood and urine, as indicated in a case reported by Greene and Johnston.³ Their patient succumbed to acute streptococcal infection of the upper respiratory tract with bronchopneumonia. In a series of 64 patients with Addison's disease reported by Thorn and co-workers,¹⁰ 5 died in crisis following intercurrent infection. The hemolytic streptococcus was the most common offender.

Sulfadiazine was used successfully by Thorn and Lewis¹¹ for acute hemolytic streptococcus in 2 patients with Addison's disease. In 2 other patients the drug proved to be toxic so treatment could not be continued. Both of the latter patients died. The sulfadiazine was used in conjunction with other known supportive measures such as intravenous fluids with dextrose and salt, cortical hormone, desoxycorticosterone acetate and epinephrine in oil.

The potential seriousness of trivial infections in patients with Addison's disease is shown by our experience in 2 patients with dental infection.

REPORT OF CASES

CASE 1.—An Italian woman, aged 40 years, was admitted to the hospital on September 6, 1935, in a state of circulatory collapse which readily was recognized as Addison's crisis. For the preceding six months she had felt weak, had lost 38 pounds in weight and had vomited frequently. Her husband had noticed a darkening of her complexion. Just before admission to the hospital a pharyngitis had developed. The temperature was 103° F., blood pressure 70 mm. of mercury, systolic and 40 mm. diastolic and heart rate 157 beats a minute. Marked pigmentation of the hands, extensor surfaces, neck, nipples and mucous membranes of the mouth was noted. Black freckles were found over the chest and abdomen.

The hemoglobin determination, erythrocyte count and urinalysis were normal. The white blood cell count was 15,000 per cu. mm. with a differential count of 23 per cent polymorphonuclears and 7 per cent lymphocytes. The nonprotein nitrogen was 66 mg. and the sodium chloride 512 mg. per 100 cc. of blood.

The patient was treated with dextrose and salt intravenously in doses of 10 cc a day. Subcutaneous epinephrine totalling 36 minims a day (head treatment) was given for a few days. She rapidly improved and was discharged twenty seven days later. The blood pressure was 130 systolic and diastolic. The nonprotein nitrogen was 26 mg and the sodium chloride 57. The white blood cell count was 11,900 with a normal differential count.

During the next five years the course of the patient's illness was variable. She took 8 gm of salt by mouth daily and administered 2 cc of Wilson's hormone subcutaneously twice a week. She had one episode of unconsciousness due to hypoglycemia when she did not eat for several days on account of upper respiratory infection. Relief was almost instantaneous following the administration of glucose by a stomach tube. Otherwise the blood pressure plus a slight remained satisfactory and she was able to do all her household work.

On July 13, 1941 without consulting us the patient had an abscessed left mandible extracted under local anesthesia and the following day she began to vomit. She took 45 cc of cortical hormone. The next day she was admitted to the hospital in a semistuporous state. The temperature was 100 F, pulse rate 110 and blood pressure 80 systolic and 60 diastolic. There was a brawny indurated swelling of the left side of the face and neck and of the floor of the mouth typical of Ludwig's angina.

The laboratory studies revealed the erythrocyte count to be 3,640,000 and leukocyte count 4,500. The differential count showed polymorphonuclear leukocytes 8 per cent, lymphocytes 8 per cent and monocytes 4 per cent. The nonprotein nitrogen was 30 mg and the sodium chloride 540 mg.

Treatment consisted of 5 gm of sodium sulfathiazol intravenously and 1 cc by nasal tube hourly at first and later every four hours. In the next thirty hours she received 115 cc of Wilson's adrenal cortical extract intravenously, 500 cc of normal saline and dextrose solution intravenously, 100 mg of desoxycorticosterone and two injections of epinephrine subcutaneously.

The pulse rate increased steadily, the circulation gradually failed and swallowing and breathing became more difficult due to the increasing swelling of the soft tissues of the neck. Thirty six hours after admission, while preparations were being made to incise and drain the neck and sublingual tissues, the patient died.

Autopsy revealed the adrenal glands to consist of caseous and fibrotic nodules which showed only minute amounts of adrenal cortical tissue. Typical tubercles were found on histologic examination. The sublingual tissues were edematous and on incision thin pus exuded. The cavity caused by the tubercle extraction contained a small amount of necrotic material. A blood culture taken after death grew gram negative cocci and bacilli.

Infection was responsible for three upsets in this patient's illness: (1) Just before admission pharyngitis led to a state of crisis; (2) mild respiratory infection led to anorexia and an attack of unconsciousness from hypoglycemia; and (3) dental extraction quickly led to Ludwig's angina which resulted in the patient's death.

CASE II—A man aged 30 years gave a history of progressive weakness and weight loss for several months. Following this a diagnosis of Addison's disease was made.

made in 1939 The blood pressure was 80 systolic and 60 diastolic During the ensuing five years he was treated at first with a high sodium low potassium diet with additional salt then with daily injections of 25 mg desoxycorticosterone acetate and finally with implantation of pellets of desoxycorticosterone and a high carbohydrate diet He remained in good health felt well and worked every day The last pellet implantation was on September 25 1943

During 1943 the removal of two abscessed teeth was necessary Because of our experience with Case I the patient was given a course of sulfathiazole for six days at the time each tooth was removed starting two days before the extraction The teeth were removed without local or systemic reaction and healing took place rapidly

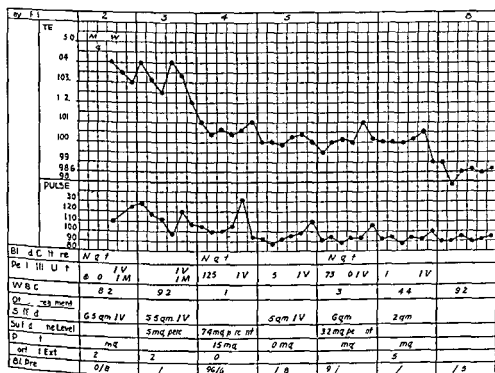


Fig 230—Clinical course of Case II

In January 1944 a dentist began packing the left upper lateral incisor at weekly intervals preparatory to fastening a gold crown in place The last packing was done on February 5 Three days later the tooth began to ache and later the same day the left cheek began to swell By evening he had become extremely weak and during the night he developed a high temperature and became stuporous

On admission to the hospital the next afternoon the patient was critically ill he was semicomatose and ashen in color The temperature was 104 F the pulse rate 110 and the respiratory rate 40 The left lip and cheek were dark red and markedly swollen The periorbital tissues of both eyes were so edematous that the lids could not be opened The mouth could be opened only slightly and was filled with dark brown foul smelling exudate The gingiva in the region of the tooth was swollen and purplish in color

Immediately on admission treatment was begun with penicillin, sulfadiazine desoxy corticosterone acetate and cortical extract. Fluid was given by constant intravenous drip in the form of 5 per cent dextrose in saline. Nasal tube feedings were begun on the second day. The daily therapy and the response of the temperature and pulse rate shown in Figure 730.

There was no noticeable change in the patient's condition on the day after admission. He was comatose and incontinent of urine and feces. The entire face was swollen to about twice normal size. On the third day he was still semicomatose but the swelling of the face and discoloration of the left cheek were beginning to subside. On the fourth day consciousness returned with periodic delirium. The swelling and redness of the face had practically disappeared. On the fifth day the face seemed practically normal. He had an occasional visual hallucination. On the sixth day he was alert and attentive and was able to take fluids and food by mouth so the constant intravenous and nasal feedings and sulfadiazine were discontinued. On the tenth day he was up and around and appeared and felt normal.

Röntgenologic examination of the offending tooth showed an apical abscess. Since it was thought best to remove the tooth, sulfadiazine was begun again and two days later the tooth was removed under local anesthesia by Dr. Harold Kent, oral surgeon at the New England Deaconess Hospital. No reaction of any kind took place. The tooth was cultured and grew *Streptococcus viridans*. On the seventh day after admission he was discharged from the hospital looking and feeling well, there being no sequelae to the serious illness.

DISCUSSION

Our experience with one fatality after dental extraction and one near fatality is additional proof of the low resistance of patients with Addison's disease to infection. An adequate explanation of the potential danger of dental extractions in patients with so little resistance is given by studies in the field of dentistry.

Miller² has shown that even simple procedures around the teeth will open the portals of infection into the blood stream. This was the sequence of events in Case II since the acute illness occurred only after picking a tooth preparatory to fastening a gold crown in place. Haden⁴ was able to culture *Streptococcus viridans* from the periapical tissue in 92 per cent of 1500 extractions. Palmer and Kemp⁵ found fourteen positive blood cultures immediately after tooth extraction in 82 patients although ten minutes later all but 1 had a negative culture. Eleven of the fourteen cultures were *Streptococcus viridans*, two were *Staphylococcus aureus* and one was diphtheroid.

These results have been confirmed by other authors.⁷ The occurrence of subacute bacterial endocarditis following dental extraction is a recognized fact and is easily explained by these observations.

In Case II sulfonamides were used prophylactically at the time of dental extractions twice in 1943 and again after his last illness. This was done without knowing that Budnitz and co workers¹ in 1942 had suggested the prophylactic use of sulfonamides in dental extractions. They reported 27 cases in which sulapyridine was used before extraction with the result that a negative blood culture was obtained in all cases immediately after extraction and thirty minutes later Northrup and Crowley⁶ reported a 4 per cent incidence of bacteremia after dental extraction with the prophylactic use of sulfathiazole when blood levels over 3 mg per cent were obtained with an incidence of 17.3 per cent with levels under 3 mg per cent.

The basis for the low resistance to infection in Addison's disease has not been adequately explained. Apparently the normal adrenal gland is in some way involved in the mechanism of combating infection. Relative failure of these patients to show a leukocyte response has been noted by Thorn^{10, 11} but this was not observed in our cases as Case I had a white cell count as high as 24,000. When patients are maintained on desoxycorticosterone acetate only the salt and water metabolism mechanism is restored to normal. The known inadequacy of desoxycorticosterone acetate is the basis for giving cortical extract at the time of infection. It is assumed that the cortical extract contains an infection combating substance. The benefit which can be expected from this source may be limited by the expense of sizable doses.

In the management of Addison's disease advice should be given to the patient regarding the seriousness of infections and the need of medical care at that time. Special emphasis should be placed on caution concerning dental surgery.

SUMMARY

The low resistance of patients with Addison's disease is again emphasized and the serious consequences of dental manipulation are reported.

One patient died sixty hours after a tooth extraction having developed Ludwig's angina. She failed to respond to sulfathiazole and the usual supportive treatment. The second patient developed a fulminating cellulitis of the face after minor packing of a tooth. He recovered from what was thought to be a fatal illness with the use of penicillin and sulfadiazine. The penicillin was thought to be responsible for the patient's recovery since the first patient died in spite of adequate sulfonamide treatment.

Sulfathiazole was used on two occasions and sulfadiazine once preparatory to dental extraction in 1 patient with Addison's disease with gratifying results. The prevention of infection by this means is recommended as a routine measure in Addison's disease when dental manipulation is contemplated.

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POSTOPERATIVE MANAGEMENT OF SPINE FUSION WITH AND WITHOUT HEMI LAMINECTOMY

GEORGE L THOMAS

In patients subjected to spine fusion the postoperative care is designed to provide sufficient immobilization to result in a firm arthrodesis as well as to preserve the maximum muscular function of the low back throughout the entire postoperative period. The technical aspects of the operation employed at the Lahey Clinic for spine fusion have been described by Haggart and Toumey¹

Briefly the site of fusion is prepared carefully by removing the articular cartilage from the adjacent facets excising the spinous processes and preparing the fusion bed. A multiple chip fusion is then constructed at this area. We feel that it is unnecessary to employ massive tibial or osteoperiosteal graft since experience has shown that adequate stability at the lumbosacral area can be obtained with the procedure described.

Following arthrodesis of the lumbosacral joint the patient is hospitalized from twenty four to twenty eight days. Those patients who require a fusion from the fourth lumbar vertebra to and including the sacrum are given an additional seven to ten days of hospital care. No attempt whatsoever is made postoperatively to immobilize the patient completely. All forms of rigid external fixation such as Bradford frames casts and braces are avoided. The patient is allowed complete freedom of motion in bed with the exception of the sitting position. In lumbosacral fusion the patient is allowed to sit up on the twenty first day whereas with a more extensive fusion that is from the fourth lumbar vertebra to the sacrum the patient remains flat in bed until the twenty eighth day after the operation. An occasional patient with exceptionally strong back muscles has required an even shorter period of postoperative bed rest.

The patient's bed is made as firm as possible by inserting a large plywood board between the mattress and the spring. Hand rings suspended from a Balkan frame greatly facilitate nursing care. The patient is allowed to assume the prone supine or side position at will but he is cautioned to avoid acute anterior and lateral flexion rotation or extreme extension when he is moving about in bed. We believe that the tone and strength of the low back muscles are well maintained under this regimen while the degree of mobility permitted has not appeared to interfere with the objective namely a firm bone fusion. Patients do not later exhibit the definite stiffness and extensive muscle atrophy which in our experience follows prolonged rigid fixation.

Whenever possible the patient is trained preoperatively in low back muscle exercises which he can perform in the supine or prone position. These exercises have particular reference to the training of the muscles of the low back and gluteal groups. In this same period, every attempt is made to develop muscle tone. When it is necessary to initiate this program during the patient's convalescence exercises are begun during the third postoperative week. The practice of the exercises maintains adequate muscle tone in the low back and greatly facilitates the eventual postoperative activity.

After the twenty first day the patient is allowed to sit up and dangle his legs over the side of the bed. At this time a wide lumbosacral belt with steel strays or a low Taylor back brace is applied and the patient begins to walk. Every effort is made to correct any faulty postural habits immediately after the patient is up and about. If a functional list of the trunk or tendency to marked lumbar lordosis is observed such deformity can best be corrected at this time. Careful attention is paid to posture. The patient is taught to sit, stand and walk correctly and to avoid any faulty postural habits he may have had preoperatively.

When hemilaminectomy for disk protrusion is employed without spine fusion the management is essentially the same as that which I have already described. However these patients are in bed a much shorter time, a maximum of ten days to two weeks in the average case. The same careful attention to posture is employed while braces and supports are utilized only for those patients with very inadequate musculature. Many of these patients have been incapacitated over a long period of time and hence require a period of strenuous muscle training to develop adequate muscle function which can be instituted only when freedom from pain will allow such a regimen. Again, the exercises are taught preoperatively and the low back muscles are developed before surgery if this can be accomplished with a reasonable degree of comfort. We believe that a few weeks devoted to muscle development greatly facilitates complete recovery in a minimum period of time.

COMPLICATIONS

Acute urinary retention is the most frequent and immediate postoperative complication. To overcome this tendency the parenteral fluid administration often approaches 2 500 to 3 000 cc. within twelve hours after the operation. Within ten hours it is usually possible to decide whether the patient will require catheterization. If 800 or 900 cc. is obtained at the time of the first catheterization it is probable that this procedure will have to be repeated. When the bladder is completely drained 2 ounces of one half of 1 per cent aqueous mercurochrome is instilled. This drug may be a mild antiseptic but the particular objective is to introduce a mild irritant which decreases

the bladder sensory threshold. If subsequent catheterizations are used they are performed every six hours and the mercurochrome instillation is repeated. If voluntary micturition does not occur after the second day or the bladder residual exceeds 2 ounces an indwelling catheter is inserted and allowed to remain in place forty eight hours. Undue distention of the bladder thus is avoided and most patients are able to void voluntarily during the second or third postoperative day.

Any tendency to *gastro intestinal distention* is controlled in the early postoperative period by the use of continuous gastric or duodenal suction. The average patient is given solid food as soon as he will take it certainly within forty eight hours postoperatively and this tends to promote early bowel function.

Constipation readily is controlled by the use of oil retention enemas followed by a cleansing enema twelve hours later. We have had no anal sphincter complications in the last 150 cases in our series.

Every attempt is made to attain an optimum blood picture preoperatively. Most of our patients who have had a combined hemilaminectomy and spine fusion have been transfused during the operation and this was repeated postoperatively if indicated. Transfusions are administered on the basis of promoting rapid convalescence as well as preventing immediate surgical shock. It may also be a factor in preventing the intravascular clotting accidents which accompany postoperative hypotension.

In our series *respiratory complications* are conspicuous by their absence. This is probably due to a number of factors. When general anesthesia is used the anesthetist is careful to aspirate any fluid which accumulates in the upper respiratory tract before the patient leaves the operating room. The binders which are applied are always sufficiently loose to allow full chest expansion and the patient is directed in deep breathing exercises which he begins on regaining consciousness and continues several times daily during the entire period of bed rest. The freedom of motion in bed which the regimen allows is also of value in preventing pulmonary congestion.

Extensive bone work appears to cause a rather marked *fall in blood pressure*, particularly in patients having spinal anesthesia. A satisfactory pressure level is maintained with transfusion which is administered before any appreciable fall in pressure occurs.

DISCUSSION

The preceding remarks are based on our experience with 150 patients who have undergone hemilaminectomy and spine fusion and have been handled postoperatively in the manner described. In the management previously employed the patient was confined to bed much longer and immobilized postoperatively with some form of external fixation. A comparison of our results has led us to believe

that the period of total disability has been reduced markedly when our attention is focused primarily on the maintenance of musculoskeletal function throughout the entire preoperative and postoperative course

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THE MANAGEMENT OF ACUTE POSTOPERATIVE PAROTITIS

HUGH F. HARE

ACUTE parotitis is a rare postoperative sequela which may develop at any time during the first week following surgery but usually occurs within forty eight hours. The disease is associated with pain and swelling in the region of the parotid gland and a sudden elevation of temperature denotes the onset. The frequency and severity of this condition has decreased with improvement in preoperative and postoperative care. Also patients who require surgery are operated on before a moribund condition develops. In our experience the early diagnosis and treatment of acute parotitis by roentgen rays or radium with supportive measures has been gratifying. Because of the seriousness of this condition if neglected and the reported high mortality it requires careful consideration. Sporadic reports indicate that some writers advocate early surgical intervention. Our results show that radiation is the treatment of choice because the disease usually can be controlled readily and the unsightly scar of surgery and prolonged postoperative drainage are obviated.

ETIOLOGY

The mode of onset of acute suppurative parotitis has not been established and any discussion of this subject is purely academic. Most of the theories that have been advanced are not sufficiently sound to withstand a critical study. There may be several origins and perhaps each case should be studied from an individual point of view. In most cases the suddenness of onset is characteristic and a thorough study fails to reveal whether the disease started as a result of an infected embolus to the parotid gland, an ascending infection of the parotid duct, manipulation of the patient's jaw while under anesthesia or has spread by contiguity from inflamed and infected adjacent tissue.

Manipulation in and around the salivary gland is not in itself a contributing factor in the causation of parotitis. This is proved by the absence of acute parotitis following thyroidectomy in a large series of cases at the Lahey Clinic during the last ten years. Nor does the theory of contiguity of inflamed tissue bear close scrutiny because again none of our cases of acute parotitis has followed operation on the parotid or salivary gland or extensive operations within the mouth. Also in only 1 case has an acute parotitis followed operation on the cranial vault. Thus with the exception of ruling out ascending infection of Stenson's duct which is an impossibility unless each case could be studied prior to operation any theoretical discussion fails to reveal the mode of onset of this condition.

The symptomatology of the disease is characteristic namely pain and swelling of the parotid region usually within forty eight hours following operation. Any complaint referable to this region should be immediately and thoroughly investigated and if swelling is present, no matter how small treatment should be instituted. This condition is usually unilateral although bilateral involvement sometimes occurs. Swelling of the parotid gland is accompanied by a sudden rise in temperature and within a few hours the disease may spread to the extent that the entire face is involved or it may remain localized in only a small portion of the parotid gland.

TREATMENT

The treatment of acute suppurative parotitis may be divided roughly into five types. In some cases all types must be used to accomplish a successful result but surgical intervention has become decreasingly necessary with scientific improvement of other methods.

The following is the order of our approach to the treatment of this condition (1) preventive (2) supportive (3) radiation, (4) sulfa drugs and (5) surgical.

Preventive therapy which has become increasingly important not only for this sequel but for many others receives little credit, and yet I am sure it accounts for the decrease in the number of cases seen. The anesthetist with a better opportunity to study the case before anesthesia and to give advice concerning postoperative care as well as the surgeon and the internist undoubtedly has prevented many cases.

The routine cleansing of the mouth the use of fluids preoperatively and postoperatively and the study of the blood chemistry prior to and after operation likewise have materially decreased the incidence of the condition and have aided as *supportive* measures in treatment.

During the last ten years only 2 patients have died. One of these was a moribund diabetic patient in coma and the other was an elderly man in a moribund condition at the time of operation both of whom were considered poor surgical risks. The use of drugs candy and chewing gum to stimulate the flow of saliva is worth while especially chewing gum which increases mastication and thus aids in the flow of saliva. In most instances the careful milking of Stensen's duct on the affected side reveals purulent material in the drainage of this into the mouth by exercise is important.

Radiation treatment should be instituted immediately after the diagnosis is made even though the condition may not be severe. The purpose of this is to prevent suppuration of the gland and to bring about in arrest of the disease. It makes no difference whether radium or roentgen treatment is instituted as long as it is immediate and preoperative supportive measures are given. In my opinion several cases may be well

have aborted with only supportive measures but delay is unjustified when radiation treatment is not a risk and does not injure the patient.

In our experience only small doses of radiation treatment are necessary to bring about improvement. Superficial treatment has proved equally as valuable as deep therapy. Our custom is to use superficial therapy 125 kilovolts peak filtered through 3 mm of aluminum using a large enough portal to cover the entire parotid region including the accessory parotid gland. Usually a 10 cm square or round portal at a distance of 30 cm is sufficient. Two hundred roentgens usually are given at the first treatment and if the swelling does not materially decrease within twenty four hours a second application is given. The course of the disease as a rule is apparent within forty eight hours but unless definite suppuration has occurred at the end of that time and the swelling is still present then further radiation may be given without deleterious effects. It is important to allow enough time for radiation treatment to take effect. In our early series when the combined method of radiation treatment and surgery was employed frequently surgery was instituted at the end of twenty four hours because we were not certain that the radiation treatment was controlling the disease. At the present time surgery is deferred until radiation treatment has had an opportunity to bring about a successful result that is at least forty eight hours. The need for surgery thus has become decreasingly necessary and is used only in the extreme case in which radiation has failed to control the disease.

Radium may be as useful as roentgen rays in the treatment of parotitis but it is more difficult to use and is more expensive for the patient. We prefer when possible to use the latter even though it requires removal of the patient to the x ray room. Most of our institutions are so equipped that the bed may be moved to the x ray room without disturbing the patient but if this is impossible radium must be employed.

Since the radium applicators are heavy the application of radium to the cheek on the affected side usually increases the discomfort of the patient and requires the cooperation of the patient during the period of application. The shorter period of time it can be used the better. Four hundred millicuries of radium are used filtered through 2 mm of brass at a distance of 1 cm from the skin leaving it in place one hour to give a total dose of 400 millicurie hours at 1 cm distance. This application is repeated in twenty four hours if necessary.

With our apparatus this requires the application of double coated adhesive for the wooden block one side of which is attached to the skin and double coated adhesive to attach the radium to the wooden block. Then adhesive is put across the entire apparatus to hold it in place. No patient has complained unduly of this apparatus but when the patient is ill it is difficult to obtain cooperation and an experienced attendant must remain at the bedside during treatment to be certain

not included in this group the polyps were scattered over the entire gastric mucosa (Fig. 232) and in 1 case they involved the distal part



Fig. 31—Benign perineural fibroma of greater curvature of stomach. Most tumors of greater curvature are malignant. Smooth rounded defect more characteristic of benign tumor.



Fig. 32—Benign adenomatous polyp of stomach. The large mass is due to benign adenomatous polyp in lining of the stomach.

of the stomach (Fig. 233). It is the general opinion that adenomatous polyps not infrequently become malignant (Fig. 234). Pedunculated polyps arise most commonly in the mucosa of the antral portion of the

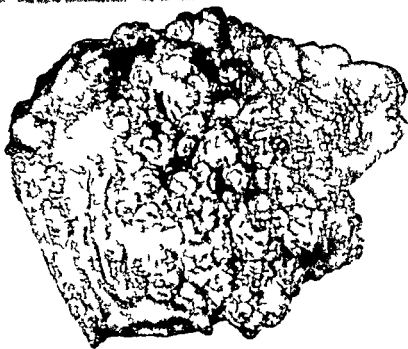


Fig 33—Specimen of resected stomach showing multiple adenomatous polyps involving distal half of stomach. Pathologic examination revealed malignancy in one area.



Fig 34—Adenomatous polyp in distal part of stomach with malignant degeneration upon pathologic examination.

stomach and may prolapse through the pylorus and produce obstructive symptoms.¹⁷ Prolapse of gastric mucosa through the pyloric ring may simulate a prolapsed adenomatous polyp upon roentgenologic examination but gastric analysis shows normal acid values and blood studies usually show no anemia (Fig. 235).

Occasionally aberrant pancreatic tissue occurs as a tumor mass along the greater curvature of the stomach most commonly near the pylorus. We have noted this on three occasions. The preoperative diagnosis is usually gastric tumor probably carcinoma.



Fig. 235—Prolapsed gastric mucosa is seen as a small rounded filling defect or fleck of lumium in center; the latter is not seen in prelaps adenomatous polyp.

Benign gastric tumors have a tendency to hemorrhage. Characteristic clinical findings are achlorhydria and secondary anemia. These findings together with a history of long standing gastric distress should make the physician consider the possibility of a tumor. Probably most of these tumors are discovered incidentally on roentgenologic examination of the stomach during a complete gastroenterologic investigation or are discovered during laparotomy for other intra-abdominal disease.

This particular group of benign gastric neoplasms includes adenomatous polyp, neurofibroma, leiomyomas and lipoma (Table I).

TABLE 1—TUMORS OF THE STOMACH 464 CASES

<i>Benign Tumor</i>	
Fibro adenoma	1
Neurofibroma	1
Leiomyoma	6
Lipoma	1
Total	<u>9</u>
<i>Malignant Tumor</i>	
Carcinoma	440
Sarcoma	15
Total	<u>455</u>

MALIGNANT TUMORS

As previously mentioned most gastric tumors prove to be malignant at operation and are commonly carcinomatous. However the various types of *sarcoma* occasionally occur and in this series 15 of the 455 malignant tumors were sarcomas (3.2 per cent). Of these 2 were leiomyosarcomas and 13 belonged to the lymphoma group (Table 2). There was 1 sarcoma to 29.3 carcinomas.

TABLE 2—MALIGNANT TUMORS OF THE STOMACH 252 RESECTED CASES

<i>Sarcoma</i>	
Lymphoma	
Lymphoblastoma	1
Lymphosarcoma	4
Hodgkin's disease	8
Total	<u>13</u>
Leiomyosarcoma	2
<i>Carcinoma</i>	
Initis plastica	
Mucinous adenocarcinoma	13
Carcinoma simplex	121
Epidermoid carcinoma	1
Ulcer with carcinoma	
Adenocarcinoma	95
Adenoacanthoma	1
Unclassified	
Total	<u>237</u>

The literature indicates a considerable variation in the frequency of gastric sarcoma.¹⁴ De Amesti reports an incidence of 1.4 per cent or 1 sarcoma in 69 gastric tumors. D'Aunoy and Zoeller⁴ report an occurrence rate varying from 1 to 8 per cent. Ewing⁶ states that sarcoma is infrequent about 1 per cent of malignant tumors of the stomach being sarcomas. This figure closely parallels the experience of the Mayo Clinic where sarcoma was encountered in the proportion of 1 sarcoma to 111 carcinomas.

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Fig. 35.—Prolapsed gastric mucosa is seen as a small rounded filling defect with flank of contrast in center the latter is not seen in prolapsed adenomatous polyp.

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This particular group of benign gastric neoplasms includes 1 adenomatous polyp, 1 neurofibroma, 6 leiomyomas and 1 lipoma (Table I).

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Leiomyoma	6
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Total	<u>9</u>

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Sarcoma	15
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Definite pathologic classification may be uncertain. An occasional round or spindle cell sarcoma may be found but the most frequent type is lymphoma such as lymphosarcoma or Hodgkin's disease. The lymphomas are probably a local manifestation of lymphosarcoma or Hodgkin's disease which has its origin in the lymphoid tissue of the stomach but may develop in any part of the lymphatic system. The initial growth is first noted in the stomach and often may be cured, either by partial or complete resection of the stomach. The prognosis for prolongation of life may be good especially if followed by carefully supervised roentgen ray therapy.



Fig. 36—Large leiomyosarcoma in body of stomach. Roentgenogram shows filling defect at distal end of stomach. Tumor is described as a sharp relief. Removed by total excision.

Two of these sarcomas were well defined tumors the leiomyosarcomas. A leiomyosarcoma represents malignant degeneration of a benign leiomyoma resembling in its origin from smooth muscle myosarcoma of the uterus and is easily recognized clinically and pathologically. They are often large project into the lumen of the stomach which most frequently brings the patient to the physician is massive gastric hemorrhage occasionally even producing marked exsanguination. Gastric symptoms other than bleeding may be minimal even in the presence of a large tumor.

A leiomyosarcoma is readily resectable and operation offers an ex-

cellent prognosis because of the relative low grade malignancy of the tumor and the tendency to late metastasis.¹¹ One of our patients is alive and well over six years following total gastrectomy and another patient is alive and well over four years following local excision of a large leiomyosarcoma.

Gastric symptoms resulting from sarcoma of the stomach are not characteristic. These patients commonly complain of epigastric distress, loss of appetite and loss of weight. In other words the symptoms are similar to those arising from carcinoma of the stomach. Gastric analysis may reveal free hydrochloric acid or achlorhydria. Roentgenologic examination likewise is not distinctive although it may be suggestive. Most cases are interpreted from the clinical and roentgenologic findings to be carcinoma. The diagnosis of sarcoma may be suspected upon laparotomy but in most instances must be established from examination of the pathologic section.

Carcinoma is the most common form of tumor arising in the stomach and in this group of cases comprised 94.8 per cent of the 464 tumors found at operation. Furthermore carcinoma of the stomach is the most frequent type of malignant tumor arising in the male whereas in the female uterine malignancy occurs more frequently. Vital statistics show that in approximately 22 per cent of men who die of carcinoma the lesion arises in the stomach whereas only approximately 12 per cent of women who die of malignancy die of carcinoma of the stomach (Table 3). In 1940 there were 26,526 deaths from carcinoma of the stomach.

TABLE 3—DEATHS FROM MALIGNANCY IN THE UNITED STATES 1940

	Male	Female
All malignant tumors	75,406	87,878
Carcinoma of stomach and duodenum	16,327	10,199
Per cent of total deaths due to carcinoma of stomach and duodenum	21.6	12.3

The Bureau of Vital Statistics does not separate malignancy of the stomach and duodenum. However, since true primary carcinoma of the duodenum is rare the figures are essentially those of malignancy of the stomach.

In view of the frequency of gastric carcinoma it is a distinct possibility in any patient, middle aged or older, who has persistent gastric distress. Therefore any person who has persistent gastrointestinal distress unrelieved by a trial period of diet and conservative therapeutic measures should have a thorough gastrointestinal investigation which should include gastric analysis and roentgenologic and gastroscopic examinations. Furthermore if the evidence obtained by this study does not conclusively eliminate cancer, further roentgenologic examinations after a short interval should be performed. In event a definite decision cannot be reached, laparotomy is justifiable and indicated. Some difficulty may be encountered in distin-



Fig 238—Syphilis of stomach may be confused with carcinoma Roentgenogram shows dilated stomach and constriction and rigidity in prepyloric area Diagnosis confirmed by serology and operation Exploration only



Fig 39—Large carcinoma involving lower end of esophagus and fundus of stomach Exploration and biopsy only

Subtotal resection was performed in 180 cases (Table 4) with an operative mortality of 6.7 per cent. In 57 cases the tumor was so advanced that total gastrectomy was necessary (Fig. 240) and the operative mortality was 32 per cent. However, with a better selection

TABLE 4—MALIGNANCY OF THE STOMACH 455 CASES

Operation	No. of Patients	No. of Post-operative Deaths	Operative Mortality
Subtotal resection	180	12	6.7
Total resection	57	18	31.8
Palliative operation	40	6	15.0
Exploratory operation and biopsy	118	8	6.8

of cases with improved operative technique and with more experience in this extensive operation the mortality of total gastrectomy can be lowered as is proved by our reduction of the operative mortality during the last two years to 18 per cent.¹



Fig. 240—Specimen of extensive carcinoma of stomach removed by total gastrectomy. Note omentum and spleen removed en masse with stomach.

The types of malignant tumors found in the group of resection cases is given in Table 7.

SUMMARY

A brief report is made concerning the types of gastric tumors found in 464 patients operated on at the Lahey Clinic over a five year period. Benign tumors constituted 2 per cent of this group whereas

32 per cent of the series were sarcomas of some type. As would be expected the majority of these tumors were carcinomas the percent age being 94.8 per cent.

Resection was possible in 52 per cent of the malignant tumors submitted to operation. The operative mortality following subtotal resection for malignancy of the stomach was 6.7 per cent. The operative mortality following total gastrectomy has been reduced to 18 per cent in the last two years whereas prior to that time it was 32 per cent.

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SURGICAL MANAGEMENT OF CHRONIC PEPTIC ULCER

SAMUEL F. MARSHALL

THE treatment of peptic ulcer in general properly belongs in the province of the internist who may be especially interested in gastroenterology. However there are a number of patients whose ulcers fail to respond to conservative medical measures or develop serious complications and these patients require surgery for relief of their distress.

This report is based upon experiences in the treatment of 8,380 patients with peptic ulcer seen in the Lahey Clinic up to January 1, 1944. In this group 536 (6.4 per cent) were gastric ulcers and 7,844 (93.6 per cent) were duodenal ulcers. In this series of 8,380 cases, 19.3 per cent of the gastric ulcer cases required surgical intervention, whereas only 6.1 per cent of the duodenal ulcer cases required surgery for the relief of symptoms.

During the last seven years we have operated upon 395 patients with peptic ulcer. This figure does not include emergency operations for acute perforation of peptic ulcer. In this group a subtotal resection was performed in 318 cases and a gastro-enterostomy was performed in 75 cases. In 2 cases a previously established gastro-enterostomy was taken down and thus normal gastroduodenal function was restored. In the 318 cases of subtotal resection 56 were for recurrent jejunal ulcer which developed after gastro-enterostomy and 6 were for gastrojejunal ulcer which occurred after previous subtotal resection.

INDICATIONS FOR SURGICAL INTERVENTION

Based upon the experiences of the internist and surgeon, definite indications for surgical intervention are recognized and accepted by the majority of physicians familiar with this field of medicine. In general ulcers which are intractable to medical management, ulcers with a tendency to repeated serious hemorrhages or ulcers which produce obstruction due to repeated episodes of inflammation require surgery. Obviously acute perforation of a peptic ulcer demands immediate surgical intervention. The cooperation of the internist and surgeon is of greatest importance in the selection of these cases for surgery. This is especially true in gastric lesions in which it may be difficult to distinguish between a benign and a malignant ulcer.

More recently there has been an increased tendency to more serious consideration of the possible relationship of benign gastric ulcer and gastric malignancy which will result in a higher percentage of gastric ulcers being operated upon in the future in order to avoid over

looking carcinoma. All lesions of the stomach should be regarded as malignant until proved otherwise and should be operated upon unless evidence of healing is established by roentgenologic, gastroscopic and clinical examination. Only in this manner may malignancy be diagnosed early enough to permit operation at the most favorable time. The necessity for an adequate subtotal resection of the stomach for most of these intractable or complicated ulcer cases is well recognized.

In the majority of cases simple uncomplicated ulcer of the duodenum and stomach will respond satisfactorily to conservative medical management. Moreover a period of medical treatment assists materially in indicating which ulcer cases will need surgery for relief. More important however to the surgeon this period of rest in bed plus an ulcer diet and alkaline therapy is of utmost value in reducing inflammatory exudate about the ulcer and may definitely convert a potentially difficult technical procedure into a relatively simple one. No peptic ulcer with symptoms of acute inflammation should be operated upon until these signs to a large measure have subsided.

These inflammatory changes ordinarily involve and extend into the pancreas as most chronic callous ulcers which require surgery are located on the posterior duodenal wall the base of the ulcer extending deep into the pancreatic parenchyma. Extensive dissection for removal of the ulcer in the presence of such acute inflammatory infiltration may result in a serious pancreatitis and death.

A chronic penetrating callous ulcer of the first part of the duodenum usually can be removed without great technical difficulty or risk. If one is aware that the base of the ulcer consists of scarred pancreatic tissue and that the duodenal wall at this point is completely eroded the dissection is made easier by detaching the orifice of the duodenal penetration from its ulcer base. There is no necessity for excision of the ulcer base in the pancreas so that pancreatic injury can be kept at a minimum or entirely avoided.

The removal of an ulcer arising in the second part of the duodenum may be difficult because of encroachment on or involvement of the common duct with the inflammatory exudate. In each instance the relationship of the duodenal ulcer and the common duct should be determined before any gastric resection is undertaken. The common duct must be visualized and the duodenum must be mobilized by incision of the peritoneum at its lateral border. Then a decision can be made as to whether sufficient uninvolved duodenum remains above the ampulla of Vater to permit safe closure by inversion of the duodenal stump without damage to the common duct. Occasionally it is helpful to open the common duct and to pass a catheter through the ampulla into the duodenum thus disclosing the position of the common duct opening in the duodenum. Then the ulcer can be excised without injury to the duct.

CHOICE OF OPERATION

The possibility of recurrent ulcer has been reduced to a reasonable minimum by an adequate resection of the stomach and recurrent ulcer though it may occur infrequently appears after a sufficiently *high subtotal resection* (Fig 241)

Recurrent ulcer following *gastro enterostomy* is a much too frequent occurrence to permit the routine employment of this operation is a method of surgical treatment for peptic ulcer Nevertheless it is a valuable operation and is particularly satisfactory in older patients with low acid values and with symptoms resulting chiefly from



Fig 241—Subtotal resection of the stomach for ulcer *a* Roentgenogram of stomach before operation *b* Roentgen gram after resection Note that about three fourths of the stomach has been removed This constitutes an adequate subtotal resection

cicatricial obstruction of the duodenum or pylorus We may also have to substitute *gastro enterostomy* for the more desirable subtotal resection in a small group of patients whose general physical habits or condition does not permit the more radical procedure because of grave risk We have been compelled occasionally to utilize *gastro-enterostomy* in those patients with ulcers arising in the second part of the duodenum wherein the ulcer may encroach upon or even involve the opening of the common duct into the duodenum Extensive inflammatory reaction with marked scar fixation of the ulcer to the pancreas and common duct occasionally prevents safe dissection and

removal of the ulcer even though highly desirable and thus indicates the employment of a less hazardous operative method. Gastro enterostomy is especially indicated if a high degree of stenosis or obstruction accompanies these pathologic changes.

It is of interest to note that in the Lahey Clinic we performed a gastro enterostomy in 75 patients with peptic ulcer during the same period that we performed a subtotal resection in 318 patients for peptic ulcer. In summary we employ posterior gastro enterostomy in those patients with ulcers which appear to be irremovable because of their location, definite inflammatory adherence or dense scar tissue.

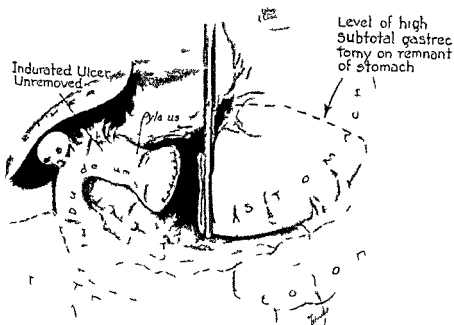


Fig 242—Subtotal resection with exclusion of the ulcer (Finsterer). This cannot be employed when obstruction is present and antral mucosa must be removed.

involvement of vital surrounding structures and also in older patients with a high grade of cicatricial obstruction or whose general physical condition is too poor to permit an adequate gastric resection.

Finsterer's method of subtotal resection with exclusion of the ulcer (Fig 242) that is allowing the ulcer to remain in situ may be employed advantageously in a limited number of patients with the described pathologic conditions but should not be used in the presence of any high degree of obstruction of the duodenum or pylorus—indeed it is definitely contraindicated in these cases. If no obstruction is present and if the ulcer is considered irremovable this exclusion method may be employed to an advantage if the antral mucosa

of the inverted stump is removed. Removal of the antral mucosa is imperative because it seems to influence the production of acid secretion in the gastric stump. Experience shows that the incidence of recurrent ulcer is apt to be high with the Finsterer operation if the mucosa is not removed. One such patient recently developed a recurrent ulcer after each of two resections the second and last resection consisting of removal of almost the entire stomach and yet the ulcer recurred (Fig. 243). Complete relief of distress and demonstrable healing of the most recent recurrent ulcer followed simple excision of the previously unremoved pyloric area. The gastroyejunal

8 25 45

a



10 11 43

b



Fig. 43—*a* Roentgenogram of gastric jejunal ulcer occurring after high resection with exclusion of the duodenal ulcer. The stomach has been resected and the antrum still is present. Note the very small gastric stump. *b* Note evidence of healing after removal of antrum. The pain was relieved immediately after operation even though the gastroyejunal ulcer was not excised.

ulcer itself was not disturbed and healed promptly after excision of the pylorus. In this group of cases we have employed the exclusive method of Finsterer in 20 patients.

We are convinced that as the experience of the surgeon increases in gastric surgery only a relatively few duodenal ulcers which involve the ampulla of Vater prove to be unresectable. In such cases after excision of the duodenal ulcer the common duct opening in the duodenum was at the very edge of the divided duodenum. Closure of the divided duodenum had to be made with a rubber tube inserted into the common duct and held in place with silk sutures to prevent

narrowing of the duct orifice. The end of the duodenum was butressed against the scarred fibrous surface of the head of the pancreas. In this patient subtotal resection was absolutely necessary and unavoidable in spite of the recognized increased operative hazard since he already had had four previous conservative operative procedures all of which were followed by recurrent ulcer. Recovery was uneventful and after five years there has been no recurrence of the ulcer.

RECURRENT PEPTIC ULCER

Recurrent peptic ulcer comprises the group of *jejunal* or *gastrojejunal ulcers* which arise following any gastrojejunal anastomosis.



Fig 244—Roentgenogram showing large jejunal ulcer occurring after gastroenterostomy

This lesion is more frequent after gastroenterostomy (Fig 244) although it may occur occasionally after an adequate subtotal resection. Many theories have been suggested to account for the development of these ulcers but none of them completely explains their occurrence. The problem was reviewed adequately in a previous communication from this Clinic.

From a practical standpoint recurrent ulcer appears to be associated with a high acid gastric secretion and any operation which is designed to produce an achlorhydria is least apt to result in the development of a jejunal ulcer. Consequently if a radical gastric resection that is sufficient to produce an achlorhydria is performed

recurrent ulcer will be infrequent and its occurrence will be reduced to an absolute minimum probably less than 2 per cent (Fig 241)

Since none of the acid secreting gastric mucosa is removed by gastro enterostomy jejunal ulcer is more apt to occur after this operation and various reports in the literature place the incidence as high as 32 per cent. One can almost be certain that jejunal ulcer invariably will follow such a conservative operation when employed in a young person whose gastric secretion is high in acid.

The surgical management of patients with recurrent ulcer presents a distinctly more difficult technical problem than the initial lesion. Consequently any surgical operation designed to relieve these patients with recurrent ulcer involves a vastly more complicated technical procedure and as a result an increased operative risk.

Jejunal Ulcer—As previously mentioned in this group of 318 consecutive subtotal resections 62 were for jejunal ulcer. Fifty six of the jejunal ulcers developed after gastro enterostomy and 6 after previous subtotal resection. Three deaths followed resection for jejunal ulcer a mortality rate of 4.8 per cent whereas the mortality rate for the whole group of resected cases which includes resection for jejunal ulcer and gastrojejunal fistula is 3.4 per cent. The mortality percentage for resection for duodenal and gastric ulcer alone is 2.8.

An individual who develops a jejunal ulcer after a gastric operation apparently has a definite tendency to ulcer development the so-called *ulcer diathesis* and any operation short of a radical subtotal gastrectomy is almost certain to result in recurrent ulcer. This is particularly true in patients developing jejunal ulcer after gastroenterostomy. Of the 62 patients with recurrent ulcer at least 10 patients had had numerous previous conservative operations before the final high subtotal resection was done. In view of this grave tendency to ulcer recurrence all patients with jejunal ulcer occurring after a previous conservative operation should have a radical subtotal resection provided the patient's condition warrants any surgical interference whatever. Additional temporizing conservative operations are of no value and only complicate the technical management of a radical resection to which the patient eventually has to submit for relief of his symptoms. The operative risk of an extensive resection of the stomach obviously is increased when complicated by dense adhesions adherent abdominal viscera and jejunal ulceration.

The mobilization of an adherent jejunal ulcer which has developed after a posterior gastro enterostomy is often extremely difficult and may result in unavoidable injury to the blood supply of the jejunum or of the transverse colon. In a no loop posterior anastomosis with induration and exudative reaction involving the jejunal mesentery the separation from the ligament of Treitz without injury to vessels of that segment of bowel may prove most difficult.

In event of injury to and enforced ligation of the middle colic

artery resection of the transverse colon must be performed as gangrene of the transverse colon will follow ligation of this blood supply. This accident occurred in 1 of our cases and the necessity for resection of the transverse colon was apparent within a few minutes after ligation of the middle colic artery. After a somewhat prolonged convalescence this patient made a satisfactory recovery. In still another patient the gastrojejunal anastomosis was found to have been made on the right side of the middle colic artery a situation which does not lend itself to ready mobilization.

After the gastrojejunal anastomosis has been dissected free from the mesocolon the problem of jejunal restoration must be handled. This may be accomplished by a V shaped incision in the jejunum detaching the jejunum from its gastric anastomosis and closing the defect in the jejunum transversely. The ulceration and induration of the jejunum may be so extensive however that resection of the jejunal segment containing the ulcer may be necessary thus requiring an end to end anastomosis to restore jejunal continuity.

If a no loop anastomosis has been used to establish the gastrojejunostomy an end to end jejunal anastomosis with the short proximal jejunum may be difficult. Division of the ligament of Treitz often will permit mobilization of sufficient proximal jejunum to allow a safe jejunal anastomosis. Only after such an extensive preliminary procedure may one proceed with the usual subtotal resection of the stomach.

Gastrojejunocolic Fistula—Gastrojejunocolic fistula is perhaps the most serious complication of recurrent peptic ulcer. It is not an uncommon complication of jejunal ulcer (about 11 per cent) and its surgical management presents a serious problem because of the high mortality associated with any operation devised for its treatment. Small gastrojejunocolic fistulas may be operated upon fairly safely provided there is little reaction about the fistula. The tract may be excised closing the rent in the colon transversely and then proceeding with an immediate subtotal resection of the stomach. Large fistulous openings present a more difficult problem because of the extensive exudative reaction involving the colon and mesocolon and because mobilization and resection of the involved bowel are apt to be associated with peritoneal contamination. Furthermore the extent of induration in colonic wall and mesocolon does not permit safe closure of the fistulous opening in the colon the operative mortality is apt to be high and death will be due to peritonitis resulting from contamination during the extensive dissection.

Because of these difficulties an operative method has been developed in this Clinic for the management of these large fistulas (Fig 245). This operative approach has now been employed in 11 patients with a large gastrojejunocolic fistula with 1 death resulting from peritonitis. This death occurred in the second patient upon whom

this operative method was employed and we believe that with more experience and improvement in the procedure the risk can be kept at a minimum

This operation divides the procedure into two stages. In the first stage the terminal ileum is divided near the cecum and the distal end of the ileum is inverted, closed with silk sutures and dropped back into the peritoneal cavity. The proximal end of the ileum is also closed and a side to side anastomosis is made between this loop of

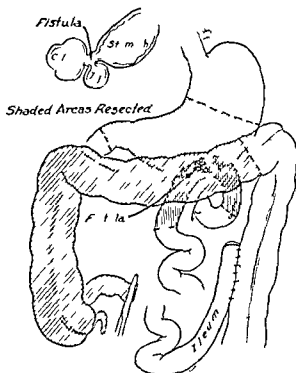


Fig. 245—Gastrojejunocolic fistula. Line drawing illustrating portions of the stomach, jejunum and colon resected at second stage of the operation. Note that in the first operation the terminal ileum is divided and an anastomosis is established between the proximal divided end of the ileum and the colon. This is in most cases the descending colon.

ileum and the transverse or descending colon as may be necessary so that the ileocolostomy is distal to the fistulous opening in the colon. Thus the contents of the small intestines are discharged into the colon distal to the fistula and cannot re-enter the stomach through the colonic fistula.

After an interval of six to eight weeks the second stage of the operation may be performed. The second stage was performed in the first 2 patients during the initial hospital admission that is within two or two and a half weeks after the first stage. A longer interval between

operations is desirable as this will permit the patient to gain in weight and to improve considerably in health since there is an opportunity for him to retain more food for digestion and absorption which was not possible before. Indeed all of these patients improved remarkably in weight and general health in the interval between the first and second stage of the operation.

The second stage of the operation consists of resection of the short segment of the inverted distal ileum the cecum ascending and transverse colon including the fistulous area in the colon up to and just proximal to the ileocolic anastomosis which was established at the first operation. A segment of jejunum containing the fistula is resected re-establishing the jejunal continuity by an end to end anastomosis. A high subtotal resection of the stomach completes the operation.

This operation is not of as great magnitude as it would appear at first consideration because the removal of the colon greatly simplifies the resection of the jejunum and stomach. The ultimate results have been excellent the operative mortality in this small series of 11 cases being 9 per cent (1 death in 11 patients resected) which is a notable reduction from previous reports in the literature and from our past experience.

Partial gastrectomy does not insure complete immunity against the development of gastrojejunal ulcer but recurrence is infrequent (probably less than 2 per cent) and certainly much less than after gastro enterostomy.

It is our opinion that if we produce a relative postoperative achlorhydria by removal of enough of the stomach (two thirds to three fourths) the risk of recurrent ulcer after gastrectomy is slight. Certainly our experience with gastrojejunal ulcer after *subtotal resection* is associated with our earlier cases in which in several instances the gastric resection was not as radical as today. Our method of subtotal resection provides for a high resection of the stomach. Postoperative determinations of gastric acids have demonstrated in most instances a complete absence of free acid or very low acid values.

Pylorectomy or *antrumectomy* is of no value in the control of peptic ulcer. The operative risk associated with these insufficient operations is as high as that of a properly executed subtotal resection moreover the chance of recurrence is considerable (Fig 246). Failure to remove a considerable portion of the acid secretory mucosa failure to produce an achlorhydria and especially failure to remove the pyloric antrum will almost certainly result in a gastrojejunal ulcer.

Recurrence of digestive distress blood in the gastric contents or stool or pain in the epigastrium is almost certain evidence of a gastrojejunal ulcer. This may be confirmed by roentgenologic examination and on two occasions at the Lahey Clinic we have confirmed such a complication by gastroscopic examination. Gastroscopic examination however may be hazardous in the presence of an ulcer in a resected

stomach and must be employed with caution. Gastrojejunal ulcers after a high resection are more amenable to medical therapy than those developing after gastroenterostomy probably because of the marked reduction in acidity which permits more ready control of remaining acidity by ulcer diet and alkaline substances.

However an exaggerated tendency to recurrent ulcer does seem to occur in some patients in spite of an adequate partial resection and in



Fig. 246—Roentgenogram of an inadequate resection of the stomach. Most of the stomach still remains and a large gastrojejunal ulcer is present at the gastrojejunal anastomosis. Reoperation with removal of the ulcerated jejunum and a large portion of the stomach produced an achlorhydria and a complete relief of symptoms.

spite of good postoperative supervision. These patients present one of the most difficult problems that the surgeon may encounter. These ulcers may recur with amazing rapidity and 1 patient developed a large jejunal ulcer six weeks after resection of the stomach. As previously mentioned 6 of the 67 patients with gastrojejunal ulcers required a further more radical resection for gastrojejunal ulcer developing after partial resection.

SUMMARY

The surgical management of chronic peptic ulcer including gastrojejunal ulcer and gastrojejunocolic fistula is discussed. This report is based upon a study of over 8,000 ulcer patients. The following points are emphasized. Conservative operative procedures are of great value

in certain densely adherent duodenal ulcers or in ulcers involving the common bile duct. However, radical subtotal resection of the stomach offers the greatest chance of permanent relief and is less likely to result in recurrent ulcer.

Furthermore, radical subtotal gastrectomy is absolutely necessary for relief of gastrojejunal ulcer. Temporizing operative procedures in the face of recurrent ulcers are valueless and only serve to increase further the operative risk.

A series of 318 subtotal resections for ulcer and its various complications is reported. This includes gastrojejunal ulcers and gastrocolic fistulas. The operative mortality for the whole group was 3.4 per cent. In a group of 67 patients with jejunal ulcer the mortality percentage was 4.8, whereas in a group of 74 patients resected for gastric or duodenal ulcer the mortality percentage was 2.8. Eleven patients were operated upon for gastrojejunocolic fistula with 1 death.

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PREOPERATIVE PREVENTION AND POSTOPERATIVE MANAGEMENT OF PEPTIC ULCER

MARTIN L. TRACEY

MANY patients with peptic ulcer are uninformed concerning what to expect from this disabling lesion and the necessity for prolonged supervision of their condition. With this in mind the physician should instruct patients in the manner of combating and if possible preventing recurrences. Such recurrences are a burden on the patient's economic efficiency as pointed out by Crohn¹ who reported that 31.6 per cent had an average annual incapacity of 30 days, 27.7 per cent from 14 to 28 days, 17.7 per cent from 7 to 14 days and 7.3 per cent from 1 to 7 days.

A review of the histories of many patients with ulcer indicates that faulty eating habits are more culpable than so called subclinical vitamin deficiency. School children who are allowed brief luncheon periods often eat rapidly so that they can spend most of their time at play. Business men often work late into the afternoon pausing only to eat hurriedly because of demanding hunger contractions. Factory workers often say that they have no luncheon period that is they work on a 7 A.M. to 3 P.M. shift or that there are no food facilities nearby. When cafeterias are available the food is not such as to allow a patient following a diet for peptic ulcer to choose an average meal. Ulcer patients should have their main meal at noon in order to minimize stimulation of night secretion. The correction of rapid eating and the hurried inadequate breakfast which seems so popular (orange juice, toast, perhaps cereal and coffee) should find more advocates in the public press and radio if we wish to prevent much indigestion. Dyspepsia of one form or another is so common among defense workers that perhaps constructive critical survey of this problem is more important than in adjustment of wage scales.

The chronicity and recurrence of peptic ulcer is often due to the patient's unfamiliarity with the nature of his disease. When the patient is discharged and is no longer under the direct supervision of a physician he often lapses into former habits. Sooner or later with a return of symptoms he attempts self medication on a similar program to that formerly prescribed and if unsuccessful he may try something different on the advice of well meaning friends or a radio advertisement. Next to constipation, headache and supposed vitamin deficiency, no other syndrome prompts more self medication than does peptic ulcer. Such self medication protracted until a calloused or complicated ulcer compels the patient to return to the physician can be prevented by instruction in a permanent supervised readjustment plan immediately.

ately after the diagnosis is made. The large number of patients with peptic ulcer presents a fertile field for instruction since the life history of ulcer can be said to end only with the life of the patient. Most patients who understand their disease are cooperative in trying to avoid a return of this disabling condition.

Since ulcer is so closely simulated by other illnesses of the gastrointestinal tract a careful diagnosis on the basis of the history is worthless unless it is confirmed by every diagnostic aid available. The patient without ulcer should not be burdened with the rigid restrictions imposed by such a diagnosis unless the findings are positive.³ If the history is not clear cut the biliary tract, colon and genito urinary tract should be studied.

The Army of the United States does not accept a diagnosis of pulmonary tuberculosis in the absence of the tubercle bacillus but with positive roentgenologic findings a diagnosis of pulmonary tuberculosis suspect is filed until the presence of the bacillus is established. A patient with a typical history and negative findings should be considered a duodenal ulcer suspect until the physician is satisfied that a lesion is present or a proper protective regimen has thwarted the lesion in its incipency with little chance of its establishment. The latter state of course demands a supervised check up for many years. In borderline cases repeated roentgenologic examinations, gastric analyses and examinations of the stools on a meat and fish free diet for occult blood should be undertaken preferably under optimum conditions in the hospital. The gastroscope should be used in patients with a questionable gastric lesion or delayed healing of a gastric ulcer.

Cooperation is best insured by explaining to the patient the nature of his affliction and the plan of treatment. This should be done during the consultation set aside for diagnostic results. The following points should be stressed:

- 1 Chronicity with a natural tendency to recur
- 2 Protection of the healed lesion is as important as the original healing. Comfort and cure are not synonymous therefore supervised treatment is required long after comfort is established.
- 3 Necessity for gastric analyses and roentgenograms every two or three months during the first year of treatment twice yearly the second and third years and yearly after that if progress is satisfactory.
- 4 Most ulcers can be healed but severe intractable recurrences or complications may need surgical intervention. Since many patients hope for surgical cure it is advisable to explain that surgery though necessary in many cases is palliative rather than curative. It affords better chances for control with less chance of recurrence but it must be followed by medical measures similar to those used preoperatively. Therefore sur

gery is reserved for patients with complications and recurrences for which one or more periods of medical management have been ineffective. They should be told early during medical treatment that surgery may be followed by a new and more severe ulcer unless a sensible postoperative program is adopted. Therefore they should so live that constant control of ulcer symptoms is possible and thus probably avoid surgical treatment.

All patients should be advised that hospitalization affords the best opportunity for healing. Complete rest is afforded best by bed rest in a change from the usual environment. Such hospital rest, which minimizes contractions of abdominal musculature, is necessary when the diet is deficient in calories and variety and when complete neutralization of gastric acidity is desirable. Night medications may be administered satisfactorily only with constant supervision and the neutralization can be checked by frequent gastric analyses. The stools can be checked for intermittent loss of occult blood under optimum conditions and the diet can be adjusted to stature and weight. While the patient is in the hospital he can also be impressed with the benefits of relaxation and reeducation in the avoidance of stress and strain and thereafter he is more likely to try to avoid stress in his work and home environment.

In refractory cases a personality study should be attempted in an effort to lead the patient into a more complacent outlook and a realization that the avoidance of those situations that produced the ulcer originally demands changes in his way of living. A revised plan of work and play and occasionally a change of occupation must be prescribed.

The diet and activity gradually are advanced in the hospital and pursued for a variable length of time after discharge, changing only as gastric analyses and roentgenologic examinations determine healing and acid control. The program may seem arduous to carry on at work, but a little ingenuity and sufficient will to remain well make it readily attainable. Check ups should be continued until the symptoms are quiescent and the patient's understanding of his illness make it evident that the intervals between the check ups can be lengthened.

Gastric ulcers should be followed more frequently for failure to heal promptly and stay healed. Recurrence of a healed gastric ulcer calls for prompt surgical treatment.

Reeducation and relaxation are the keynotes of treatment. Patients should be taught to continue a rigid program of complete neutralization after hospital discharge until certain situations encouraging recurrences are past. These situations in the absence of symptoms should be outlined so that a protective program can be followed if such situations must be faced in the future.

- 1 Unusual tension in domestic or working environment
- 2 Emotional upsets that may have a prolonged effect

- 3 Excessive or frequent fatigue
- 4 Excessive work mental or physical Heavy manual work should be avoided
- 5 Infections especially upper respiratory
- 6 Dietary indiscretions
- 7 Use of tobacco or alcohol

In case of the provocation of symptoms the physician and not the patient should decide upon the proper program. Such a program allows for surgical treatment of intractable ulcers under optimum conditions before an emergency creates added risks.

After a subtotal gastrectomy a fractional gastric analysis with histamine should be performed a day or two before the patient is discharged to guide future diet and antacid therapy. The patient should continue a sane program of living with mild or a light luncheon midway between meals. Those with free acidity should have an antacid after meals and at bedtime. A fractional gastric analysis in six months, one year and two years will help to prevent recurrence and guide the patient's future course.

After gastroenterostomy in older patients who are a poor risk and have a low acidity or in patients in whom the reaction around the ulcer or in proximity to the biliary tract forbids the more favored operation (subtotal gastrectomy) a strict medical program should be followed to prevent the formation of a jejunal ulcer. In patients with high acidity in whom a gastroenterostomy must be done careful neutralization should be instituted early in the postoperative period for jejunal ulcer may form within forty-eight hours.

Finally as in other chronic illnesses such as diabetes, tuberculosis and heart disease, reeducation is the patient's best defense against recurrence. Even though this plan may seem idealistic, the chance to remain well is sufficiently great to warrant the best efforts of the physician and the patient in the maintenance of a vigorous state of health for every ulcer patient.

SUMMARY

Patients with peptic ulcer must be reeducated under medical supervision to a minimum of tension and a practical indifference to upsetting circumstances. They must assume some permanent dietary restrictions and have regular recesses from occupational and domestic routines. They are advised to return to a rigid rest schedule and a protective dietary and to report to the physician in the event of distress, new symptoms or infection. The average ulcer patient will cooperate to the extent desired by the physician. Careful and prolonged medical supervision affords an excellent opportunity to determine the intractable ulcers that will require surgery. A manner of supervision is outlined briefly and a postoperative program is suggested.

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DUODENAL DIVERTICULUM SIMULATING GALLBLADDER COLIC

Report of a Case

HUGH F HARE AND RICHARD B CATTELL

GALLBLADDER colic following cholecystectomy was noted so frequently in the past that it has become a common procedure for the surgeon to explore the common bile duct at operation in order that stones located in this region may be removed. In so doing many subsequent operations have been avoided and our knowledge concerning anomalous changes of the vessels and extrabiliary ducts has been enriched.

The case herein reported is that of a patient who presented all the symptoms of gallbladder colic namely pain in the right upper quadrant radiating to the right shoulder with associated attacks of jaundice and who at operation was found to have a duodenal diverticulum containing gallstones. The fact that the diverticulum containing stones accounted for the symptoms has been proved by the relief of symptoms. This patient had had three previous operations and numerous gastro intestinal roentgenologic examinations for this same condition. The presence of the diverticulum escaped the notice of the roentgenologist and surgeon each time as it did us on routine gastro intestinal examination.

The presence of duodenal diverticula frequently is noted on roentgenologic gastro intestinal studies. They are usually asymptomatic and therefore in the majority of instances of little clinical significance. The usual diverticulum presents a broad based neck, fills and empties rapidly and is not tender to palpation. Less often a diverticulum is found which presents a narrow neck and it is this type which may not be seen on routine studies and may be of clinical significance. In this particular instance the diverticulum did not fill at the time of the fluoroscopic examination. A careful study of the six hour film revealed a diverticulum measuring 3 by 4 cm in the only portion of the proximal bowel which contained a residual of barium. The neck of the diverticulum was not well visualized on the six hour examination, but at operation the narrowed neck of the proximal portion was noted.

A review of the literature for the last five years failed to reveal any other case of a similar nature. This indicates the rarity of such conditions and prompts us to present this case in order to stimulate other studies and to investigate other cases before operation is undertaken.

Another recent patient presented similar difficulties following cholecystectomy while the T tube was still in place. In view of our recent

experience with the reported case in injection of the T tube was performed using diodrast as a contrast medium. A dilated common duct was demonstrated and a diverticulum with a narrowed neck filled with the dye was shown lying across the common duct producing an obstruction at the point of entry of the duct into the duodenum. The diverticulum apparently took origin at the junction of the duct with the duodenum and by pressure produced obstruction but this diverticulum failed to show any evidence of gallstones on roentgenographic examination.

The present approach to handling patients with colic or obstructive jaundice following cholecystectomy is to examine the gallbladder area roentgenologically, noting any calculi in the region of the common duct. At the time of operation the common duct is explored and a T tube is left in place temporarily for drainage of the bile for a necessary period of recovery which may vary from twelve days to one year. We determine patency of the ampulla of Vater by clamping the T tube and observing the color of the stool. If closing the T tube causes pain or if the stool does not become brown the tube is injected with a radiopaque substance such as lipiodol or diodrast before it is removed. It is important to study the duodenal loop each time a T tube injection for study of the common duct is performed in order to rule out lesions in and around the ampulla which may cause obstruction to the common duct. The amount of barium necessary for studying the duodenum at the time of the cholelithogram is relatively small and its injection requires only a few minutes in addition to the injection of the contrast substance.

REPORT OF CASE

A 43 year old female was referred to the Lahey Clinic on February 4, 1942 with a history of recurrent upper abdominal pain and pain beneath the right breast and right capill accompanied by nausea, vomiting and somnolence but apparently not related to food consumption or bowel action. In the last twelve years she had had three major operations on the gallbladder and biliary tract as well as a pelvic procedure complicated by intestinal obstruction. The referring physician had stated that she was without pain since the last operation and was aware of the possibility of biliary colic.

It is noted that the present attack was the first of a series of attacks of pain in the right upper quadrant of the abdomen. The attacks were recurrent and at operation a gallbladder was removed. In 1934 five years after the operation she again had recurrent pain chiefly under the right breast and in the right side of the abdomen. After a careful study in the hospital, during which no tests or roentgenograms were taken, an exploratory laparotomy was advised. A small lump of gallbladder and cystic duct was removed. Exploration of the common duct was negative and a T tube was inserted and allowed to remain in place. The patient's convalescence was satisfactory and in the interval between 1934 and 1937 she was well. However late in 1937 she began to have more attacks.

and in 1938 a supravaginal hysterectomy and oophorectomy were done for a submucous fibroid. The postoperative convalescence was again uncomplicated for about six months when she began to develop cramplike abdominal pain associated with nausea, vomiting and severe abdominal distention. Upon exploration in February, 1939 the obstructing adhesions about the lower ileum were released. The patient gained about 30 pounds in weight and was well until November 1940 when she developed recurrence of the biliary colic with pain similar to that previously described that is beneath the right breast and right scapula and accompanied by nausea and vomiting. She was readmitted to the hospital for observation in August 1941 and although there were no definite findings it was noted that she was not relieved by biliary drainage with the duodenal tube.

The physical examination at the Clinic was essentially negative except for strong abdominal scars. Pelvic examination showed a movable cervical stump, both vaults and rectum being negative.

Urinalysis was essentially negative. The hemoglobin was 96 per cent, red blood cells numbered 4,760,000 and white blood cells 10,100. Differential count revealed polymorphonuclears 67 per cent, lymphocytes 34 per cent and eosinophils 2 per cent. Gastric analysis showed 90 cc of stomach contents, no occult blood and mucus 1+. There was free hydrochloric acid 27 and total hydrochloric acid 40. The stools were negative. The nonprotein nitrogen was 35 mg, sugar 91 mg, bilirubin 0.6 per cent and cholesterol 186 mg. The gastro-intestinal series showed that the duodenal cap, gastric motility and duodenum were normal.

In spite of the absence of findings the consensus among the surgical, gastro-enterologic and roentgenologic staffs was that the patient probably had a common duct stricture or recurrent stones. With this in mind exploration was carried out on February 28 under pontocaine spinal anesthesia.

The abdomen was opened through an upper right rectus muscle splitting incision and as would be expected after many previous operations the right upper quadrant of the abdomen was well sealed off with numerous adhesions. The adhesions between the omentum and the anterior abdominal wall were carefully freed and beginning laterally and to the right the gastrohepatic omentum and transverse colon were freed from the liver by blunt and sharp dissection until Morrison's pouch and the foramen of Winslow could be brought into view. The common duct and the portal vein were then exposed and the common duct was dissected free. A small rudiment of the cystic duct was resected. At a point immediately below this the common duct was opened and no stricture or stone was found. The ampulla was entirely patent and admitted a No. 6 Bales dilator with ease.

After inserting a T tube into the common duct careful palpation of the second portion of the duodenum revealed what was thought to be a calcified lymph gland on the posterior surface immediately inferior to the ampulla of Vater. On careful dissection this proved to be a diverticulum of the posterior duodenal wall which measured about 3 cm by 1.5 cm. The diverticulum itself contained several calculi and by probing the common duct and palpating at the same time

it was demonstrated definitely not to be associated with the ampulla or duct. The diverticulum was resected the stump was treated with phenol and alcohol and buried with a purse string suture of black silk the entire area being reinforced with several interrupted intestinal sutures of silk. The abdominal wall was then closed in layers and the patient left the operating room in good condition.



Fig 247—The six hour film shows the barium retained in a duodenal fistula. It has not visualized on previous films.

The pathologist verified the diagnosis with a report on the microscopic section showing tissue compatible with a duodenal diverticulum.

The patient remained in the hospital for sixteen days and her postoperative course was remarkably uneventful. The highest fever was 99.6 °F and the temperature returned to normal on the fourth day. She was given intravenous glucose twice daily for three days and was able to take adequate fluids by mouth thereafter. The intake and

output were normal throughout. Approximately 8 to 10 oz of bile drained from the T tube every twenty four hours. On the eighth postoperative day the T tube was clamped off periodically, finally being removed on the fifteenth postoperative day. The wound healed by first intention. The stools were brown after clamping the T tube and the digestion was good. She received only one ampule of hyal none and 100 mg of vitamin C three times a day. The diet was of the bland type containing many cooked fruits. At the time of discharge from the hospital on March 17 she had had no recurrence of pain or colic and the bowel function was satisfactory.

The roentgenograms taken during the gastro intestinal series were reviewed after operation and showed a diverticulum which had been overlooked in interpretation of the plates (Fig 247).

COMMENT

Study of the common duct and duodenal loop is important in cases of unexplained obstructive jaundice following cholecystectomy. In most instances the cause of the obstruction is located in the common duct, but a duodenal diverticulum containing gallstones may produce symptoms of obstruction, as shown by the case presented. In this case it has been at least two years since surgical removal of the diverticulum.

RADICAL PANCREATODUODENAL RESECTION FOR CARCINOMA OF THE AMPULLA OF VATER

RICHARD B. CATTELL

PRIOR to 1935 there had been infrequent attempts to remove malignant lesions of the ampulla of Vater by local excision and rare instances of more radical removals. In 1935 Whipple, Parsons and Mullins⁶ reported a radical two stage operation again calling attention to the possibility of removing such a lesion successfully. In the following eight years approximately 100 radical pancreatoduodenal resections were performed.

Most of the malignant lesions of the ampulla of Vater are low grade adenocarcinomas which metastasize late. In our 12 patients glandular metastasis was present in only 1. While the earliest symptoms may be indefinite obstruction to the common bile duct with resulting jaundice occurs relatively early so that in many cases the lesion can be suspected and a presumptive diagnosis made. Other malignant lesions may be discovered at exploration during operations on the gallbladder and bile ducts.

Since 1935 many technical improvements in pancreatoduodenal resection have been made. Whipple³ has suggested improvements in the technique of both the one stage and two stage operations as have Hunt,³ Trimble,⁴ Brunschwig,¹ and others. In 1943 I called attention to certain improvements in both the one stage and two stage procedures. These included an antecolic jejunal anastomosis of the duct of Wirsung to the jejunum as well as means of avoiding adhesions following a first stage procedure. With increasing experience in these resections further technical improvements will take place.

I have performed 15 radical pancreatoduodenal resections in the last eighteen months, 12 having been undertaken for carcinoma of the ampulla. A two stage resection was performed in 11 cases and a one stage in 4 cases. A standard technique for both procedures has been developed in order to simplify them, to avoid complications and to evaluate these methods. Since the incidence of postoperative pancreatic fistula has been reduced, complications are less frequent and only 2 deaths have occurred we believe that these techniques now have had a reasonable trial.

The one stage operation should be limited to those patients without jaundice or with only moderate obstruction. The chief reason for a one stage procedure rather than a two stage has been that the former is easier to perform. This objection to the two stage operation has been overcome by employing a first stage procedure which does not involve the field that is to be dissected in the second procedure. The

improvement of liver function and the relief of biliary obstruction between the first and second procedure are important factors in the recovery of these patients

The use of continuous or fractional spinal anesthesia is of the greatest aid in these difficult resections since the procedure is carried out under the best possible surgical conditions and since patients undergo a minimal degree of shock

REPORT OF CASE

The following case illustrates some of the problems in the management of carcinoma of the ampulla. This patient who was the first of the series to be operated on has been under postoperative observation for a year and a half

History—A woman aged 47 years first came under observation on August 15, 1942

Early in October 1941 she had a severe inflammatory condition of the mouth, tongue and throat. Nine days later her ankles became swollen and she noticed numbness of both feet. For several months she had had a great desire for sleep and had been unable to work because of weakness and drowsiness. The appetite was poor and she had lost 10 pounds in weight. The oral infection was treated locally and subsided in ten weeks. Since the general condition failed to improve she was admitted to a hospital for observation on January 11, 1942. Extensive laboratory and roentgenologic examinations were normal except for a persisting secondary anemia that failed to respond to iron and liver therapy. The diagnosis was severe secondary anemia, atypical pernicious anemia, an inflammatory process involving the biliary tract and possible neoplasm involving the biliary tract or pancreas.

Examination—At the time of examination at the Lahey Clinic in August 1942 she complained of fatigue, weakness, numbness of the feet and afternoon fever. The skin was pale and had a sallow appearance but there was no jaundice. The weight was 116 pounds. Examination of the mouth revealed pallor of the mucosa. The neck, heart and lungs were negative. Both kidneys were palpable. The liver and spleen were not enlarged. Pelvic and rectal examinations were negative. The neurologic findings were those of combined system disease plus a peripheral neuritis.

The hemoglobin was 7.9 gm (56 per cent), red blood cells numbered 3,370,000 and white blood cells 20,500. The hematocrit was 31.5 per cent. The smears showed moderate variation in the size and shape of the red cells, moderate acromia and a rare stippled cell. The platelets were increased. The cephalin flocculation was negative. The nonprotein nitrogen was 34 mg, the serum bilirubin 1.9 mg, reticulocytes 4.1 per cent, prothrombin time 105 per cent of normal and blood sugar 1.6 mg. The urine was negative for bile. Roentgenograms of the chest were negative as was an intravenous pyelogram.

The *preoperative diagnosis* was carcinoma of the pancreas or retroperitoneal sarcoma.

Operation—On August 27, 1942, exploration was performed under spinal anesthesia with pontocaine weighted with glucose. The liver

was not enlarged but was pale in color. The gallbladder was slightly enlarged. There was relatively great dilatation of the common duct. Palpation of the duodenum at the ampulla showed a firm projecting tumor. There were a number of enlarged soft glands along the cystic duct, common duct and gastroduodenal artery, and the head of the pancreas appeared somewhat larger than normal.

A one stage pancreatoduodenectomy was performed without complications. The duodenum and head of the pancreas were elevated by division of the lateral peritoneum, lifting them from the inferior vena cava. The third portion of the duodenum was freed from under

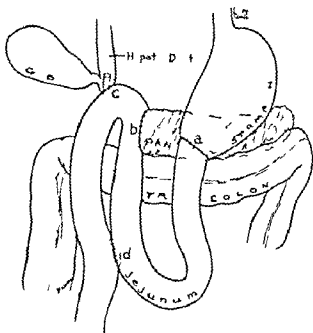


Fig. 48—The complete one stage pancreatoduodenal resection. All anastomoses are antecolic. *a* End-to-end gastroyejunostomy. *b* End-to-side pancreaticojejunostomy. *c* End-to-side choledochojejunostomy. *d* Jejunojejunostomy.

the superior mesenteric vessels. The gastrocolic omentum was sectioned, pushing the middle colic vessels downward and dropping the hepatic flexure and right half of the transverse colon. This freed up the distal third of the greater curvature of the stomach. The gastrophatic omentum was entered and the right gastric artery was located and divided. The peritoneum covering the anterior surface of the pancreas was divided across the neck of the pancreas and along the superior aspect of the head, uncovering the gastroduodenal artery, which was doubly ligated and divided. The common bile duct was freed up and sectioned 1 cm. above its entrance into the head of the pancreas. The portal vein could then be exposed and the neck and

head of the pancreas were freed from it. The neck of the pancreas was divided and the distal cut surface of the pancreas closed with mattress sutures with separate ligation of the duct of Wirsung. The uncinate process of the pancreas was freed from under the superior mesenteric vessels and the duodenum was sectioned at the junction of the third and fourth portions under the superior mesenteric vessels. The entire segment of the pyloric end of the stomach and head of the pancreas and first three portions of the duodenum were then

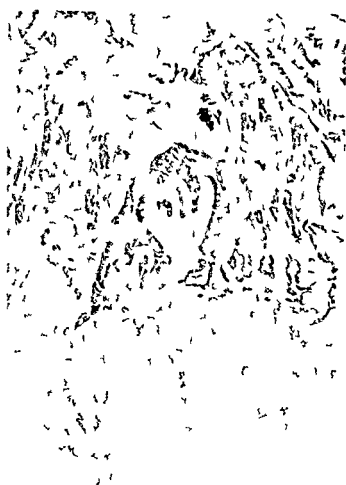


Fig. 24) - High power view of carcinoma. Bands of cells are invading the tissue. There is a tendency to alveolar arrangement.

removed en bloc. There was some question as to the adequacy of the blood supply to the fourth portion of the duodenum so the ligament of Treitz was divided below the transverse mesocolon and the fourth portion of the duodenum was drawn through its blood supply severed and the excess portion resected leaving a freely movable jejunal loop.

An antecolic end to end gastrojejunostomy was carried out (Fig. 248 a). A loop of jejunum 12 inches long was drawn up in an ante-

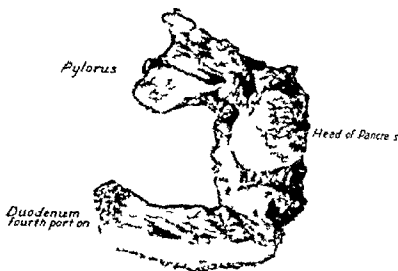


Fig. 50—External view of the specimen resected. The pyloric end of the stomach, head of pancreas, and duodenum are evident.

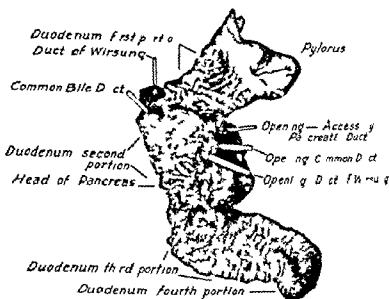


Fig. 251—The opened specimen showing the internal surface. The ducts are separated as shown. The openings to the common duct and duct of Wirsung are pushed apart by the carcinoma.

colic position and anastomosed to the closed end of the pancreatic body (Fig. 248 *b*). Two inches distal to the pancreatojejunal anasto-

mosis an open anastomosis was performed between the common duct and the jejunum over a tube (Fig 248 c) Finally a jejunojejunostomy (Fig 248 d) was performed 6 inches proximal to the pancreatic and choledochojejunostomy. A small cigaret drain was brought out from the superior aspect of the pancreas to the upper angle of the incision. One transfusion was given the day before operation and two transfusions were given during and following the procedure.

The microscopic diagnosis was adenocarcinoma of the ampulla of Vater (Fig 249). The pancreas and lymph nodes were negative. The gross specimen is shown in Figures 250 and 251.

Subsequent Course—The patient's postoperative course was excellent. When the cigaret drain was removed eight days after operation a moderate amount of turbid fluid which showed 388 units of diastase escaped. A small pancreatic fistula remained open for thirty days. She was discharged from the hospital thirty seven days after operation in good condition.

On November 7, 1942, she had gained 85 pounds. The appetite was enormous. She was continuing on a high carbohydrate high protein and low fat diet without digestive disturbances. The wound was solidly healed. There was a daily bowel movement. The stool was bulky but formed and dark brown in color.

On April 1, 1943, she weighed 115.5 pounds. The stools were now normal. Abdominal examination was negative. She was eating a normal diet, showed no evidence of anemia, and was teaching school.

On November 8, 1943, she weighed 114 pounds. She had continued working. The bowel movements were regular and the stools were normal. The appetite was good. Abdominal examination was negative.

On February 5, 1944, she reported that she was eating and sleeping normally, working daily, and was well in every way.

DISCUSSION

The diagnosis in this case presented difficulties not infrequently encountered in the early course of carcinoma of the ampulla of Vater. The symptoms and findings suggested pernicious anemia with combined system disease, and only the serum bilirubin of 1.9 mg suggested obstruction of the biliary tract. Fortunately at operation the tumor projected sufficiently into the duodenum so that it could be palpated and recognized. Examination of a biopsy specimen of the glands in the gastrohepatic omentum was negative as is usually true in these cases.

The one stage operation was satisfactory since the problem was anemia rather than biliary obstruction and decreased liver function. On the basis of my personal experience with 15 resections I wish to caution against the use of the one stage operation in the presence of deep and long standing jaundice. Satisfactory relief of the obstruction of the biliary tract even though the obstruction to the pancreatic

duct may not be relieved will improve the patient's condition and decrease the operative risk. There is an inclination to accept the one stage operation because it offers less technical difficulty.

If the surgeon finds a carcinoma in the pancreatoduodenal area which shows no evidence of metastases and seems to be operable and he does not wish to perform a radical resection or if the patient's condition does not justify it he can overcome the disadvantages of a two stage operation by utilizing a long loop of jejunum anastomosed to the gallbladder in an antecolic position without enteroenterostomy. I recommend a loop 18 to 20 inches long and a wide anastomosis so as to avoid subsequent contraction. If the operation is only palliative for the relief of jaundice then a shorter loop of jejunum (probably 8 to 12 inches) just long enough to reach the gallbladder easily should be used. The anastomosis should be of the same type but should be accompanied by a jejunojejunostomy 6 to 8 inches proximal.

If no bile is spilled and the omentum is then drawn down to cover the general area a minimal number of adhesions will be found at the second stage. No dissection around the gallbladder, common duct or duodenum should be done unless it seems essential to establish the diagnosis. Transduodenal exploration of the ampulla, exploration of the common duct or freeing up the head of the pancreas should not be done during the first stage unless there is no other means of establishing a diagnosis.

The second stage can be carried out easily if these precautions are taken. Our experience at the Lahey Clinic indicates the contrary in carrying out resection following drainage of the gallbladder, drainage of the common duct or freeing up of the duodenum.

The wisdom of doing such a radical resection for a carcinoma that is local and of low grade malignancy might be questioned. In my opinion there are a number of well substantiated reasons why the radical operation should be performed if the surgeon's experience justifies it.

The radical block dissection can be done with a reasonable mortality with an excellent expectation of cure and is in keeping with the philosophy of treatment of carcinoma. No dissection is necessary near the primary site of the malignancy and the radical procedure is less likely to be accompanied by complications than a local type of excision. One of the principal advantages of the radical pancreatoduodenal resection is that it does not leave detached portions of pancreas which may undergo autodigestion followed by retroperitoneal infection or peritonitis. It offers the best possible means of reestablishing the continuity of the gastro-intestinal tract and pancreatic duct and restoring the bile to the intestine. At the same time the entire food content can be diverted away from the site of the resection and away from the pancreato- and biliary anastomoses.

The result in this patient is rather striking. In eighteen months there

has been no evidence of recurrence. She has carried on her normal activities for fifteen months, has a normal blood picture and a normal digestion.

SUMMARY

The problems relative to the diagnosis and operative treatment of carcinoma of the ampulla are discussed based on experience with radical pancreatoduodenectomy in 15 patients.

A case report describes a one stage operation.

The advantages and indications of the one stage and two stage operations are discussed. A two stage operation is recommended in the presence of deep jaundice. A long loop antecolic cholecystojejunostomy is advised as the only procedure during the first stage.

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INTESTINAL OBSTRUCTION CAUSED BY AN IMPACTED GALLSTONE

Report of Three Cases

SAMUEL I. MARSHALL AND BERTON D. MITCHELL

INTESTINAL obstruction due to a gallstone is an infrequent but serious complication of biliary disease. When such a complication of cholelithiasis does occur it results disastrously in a large percentage of cases because of the difficulty of diagnosis. Early recognition and prompt institution of treatment are the most important considerations in successful management. As in other types of intestinal obstruction the time element is the most important single factor. The high mortality from intestinal obstruction caused by a gallstone generally reported to be 50 per cent or more is primarily due to delay in establishing the diagnosis.

INCIDENCE

In 1938 Balch¹ reviewed 8108 cases of intestinal obstruction; he found that 1.7 per cent were caused by a gallstone lodged in the intestinal tract. Ninety per cent of these cases occurred in women. Hinchey⁴ reported an incidence of 6 per cent (13 cases in women and only 1 in a man). McQueeney² found that of 7737 cases of intestinal obstruction 149 (2 per cent) were due to gallstones.

As would be expected most of these cases of intestinal obstruction occurred in elderly patients and most commonly in women. It is well known that gallstones are twice as common in women as in men^{2, 3} and that the incidence of gallstones increases with age. Dessau³ found on autopsy that below the age of 40 the incidence of gallstones was 1 per cent, whereas above the age of 80 more than one third of patients revealed gallstones. Rigler, Borman and Noble found that 75 per cent of these obstructions were in persons over 60 years of age. Hinchey⁴ reported an average age of 66 years in his series.

ETIOLOGY

Intestinal obstruction due to a gallstone most commonly follows longstanding chronic cholecystitis with stones, a condition that could be prevented if gallbladder disease were recognized earlier, evaluated properly and surgical intervention immediately instituted. A gallstone usually enters the intestinal lumen through a cholecystenteric fistula resulting from acute cholecystitis followed by gangrene and perforation into the intestines, most commonly into the duodenum. Intestinal obstruction may follow immediately after the extrusion of the stone into the intestine or may occur months or even years later.

Cases of obstruction due to a gallstone in which no fistulous tract was demonstrated at operation have been reported but unless the common bile duct and ampulla of Vater are greatly dilated which could account for the gallstone in the bowel apparently the fistulous opening into the intestine has been obliterated by scar tissue. Evidence of this in the form of dense adhesions of the gallbladder duodenum and adjacent viscera is usually present.

The great majority of the fistulas are cholecystoduodenal. Wakefield, Vickers and Walters believe that a gallstone large enough to produce complete obstruction can reach the intestinal tract in only one way that is by the establishment of a cholecystenteric fistula. Such a fistula may involve any segment of the gastro intestinal tract and although the majority involve the duodenum they may occur between the stomach and gallbladder and also between the colon and gallbladder. A fistulous tract between the stomach or upper segment of the small intestine and the gallbladder may cause few symptoms and may be compatible with reasonably good health however a fistulous opening into the transverse colon results in recurrent attacks of cholangitis from retrograde infection. Surgical intervention is imperative to prevent great damage to the liver.

In most cases the gallstone will pass through the intestinal tract without symptoms or with only mild attacks of intestinal obstruction as occurred in Case III.

A spontaneous internal biliary fistula in calculous gallbladder disease is not an uncommon complication of biliary tract disease and is sometimes associated with intestinal obstruction. Tracey and McKell⁶ reported 21 cases collected at the Lahey Clinic in five years (1937 to 1942) not one of which was associated with intestinal obstruction. In 12 patients the fistula was cholecystoduodenal in 4 patients it was between the common duct and duodenum and the 5 remaining patients had various other fistulous communications.

Wakefield, Vickers and Walters⁷ in reporting 176 cases of cholecystenteric fistula found that only 10 patients showed signs of intestinal obstruction. The size of the stone obviously is an important causative factor and most observers agree that it is usually an inch or more in diameter. However a comparatively small stone because of its shape or because of narrowing of the bowel from kinks or adhesions may become lodged in the intestine thereby causing inflammatory changes with subsequent edema, ulceration and complete obstruction. Most cases of obstruction from gallstones have occurred at the narrowest portion of the small bowel that is at the ileocecal junction.

DIAGNOSIS

The diagnosis of this condition is rarely made preoperatively but a patient presenting symptoms of acute intestinal obstruction and giving a history of long standing biliary tract disease should be suspected of

having obstruction caused by a stone impacted in the intestinal lumen. With the history and clinical evidence suggesting obstruction of the intestine roentgenologic examination may assist materially in establishing the cause as suggested by the 3 cases reported in this paper. Rygler, Borman and Noble by roentgenologic examination demonstrated contrast media in the biliary radicals in 14 of 15 cases, the contrast media being either gas or ingested barium. However the large majority of these patients are operated on with the diagnosis of *acute* intestinal obstruction the cause of the obstruction being determined upon laparotomy.

SURGICAL MANAGEMENT

The method of surgical management depends upon the patient's condition. Inasmuch as most of these patients are elderly and most of them come to surgery late after the onset of obstructive symptoms, the simplest possible operative procedure should be utilized in an effort to reduce the hazard. However a search should be made for other stones in the intestine and the gallbladder area should be palpated. The presence of a faceted stone as the cause of obstruction is indication of multiple stones and a search should be made for other stones extruded into the intestinal tract. If the segment of bowel containing the impacted stone is viable the stone may be removed through a small longitudinal incision the incision then being closed transversely to avoid narrowing of the lumen.

If possible the incision should be made in the uninvolved intestine just beyond the point of obstruction making the stone pass its point of impingement and then removing it through the opening made in the normal bowel. Incision through the normal bowel wall avoids the hazard of attempted suture of edematous dilated and thinned out bowel wall.

If the segment of the involved bowel is ulcerated or of questionable viability resection should immediately be carried out. If the patient's condition is serious and if there is marked stasis and dilatation of the bowel above the obstruction a simple exteriorizing operation such as the Mikulicz type of resection should be employed. This permits immediate drainage of the obstructed bowel through an enterostomy, easy closure of the enterostomy opening and restoration of normal intestinal continuity. However resection preferably with a side to side anastomosis because of the great disproportion in the diameter of the dilated bowel above the obstruction and the collapsed segment below should be used whenever possible. This disproportion does not permit a safe end to end anastomosis.

Immediately after resection adequate decompression of the bowel can be established by the Miller-Abbott tube thus avoiding an external enterostomy opening. The Miller-Abbott tube is also of great value preoperatively in improving the patient's condition and in de-

creasing the technical surgical difficulties. Furthermore, with such tube decompression of the greatly distended small bowel, resection and immediate anastomosis usually can be employed safely and exploration of the gallbladder area can be undertaken.

Wakefield, Vickers and Walters have emphasized that the formation of a cholecystenteric fistula does not always permit the gallbladder to discharge all the stones and they reported that 6 of 10 patients still had stones in the gallbladder. This was true in our cases. If the patient's condition warrants more extensive surgery than simple relief of the obstruction, the gallbladder should be detached from the intestine with which it communicates. A simple cholecystostomy with removal of stones can then be performed with closure of the opening into the intestines. Cholecystectomy, however, may add to the risk of the operation and in the majority of cases should be deferred. A simple cholecystostomy without closure of the communication in the bowel will result in the establishment of a duodenal fistula through the gallbladder which may present a grave problem during convalescence.

If the patient's condition does not permit investigation of the gallbladder and fistulous tract and if stones are found in the gallbladder a second laparotomy should be undertaken as soon as the patient has recovered from the obstruction and if possible before discharge from the hospital. Cases have been reported in which intestinal obstruction due to a second impacted stone recurred within a few weeks after removal of the first stone. If acute inflammation as evidenced by exudative reaction and edema about the gallbladder area should occur and if the patient's condition warrants only relief of the obstruction, a cigaret drain should be placed through a stab wound to the gallbladder area. This provides for drainage in event of progression of the gangrenous process with further perforation and peritonitis as occurred in Case I. Considerable judgment must be exercised in the management of this grave complication of gallstones and every effort should be directed toward lowering the high mortality rate.

REPORT OF CASES

CASE I—A woman, aged 64 years, was admitted to the hospital on November 6, 1935, with a forty-eight hour history of nausea and vomiting associated with crampy pain in the left upper quadrant of the abdomen and obstipation. She had had attacks of abdominal pain with constipation at intervals of six to nine months over a period of five years. There was also a history of gallbladder attacks thirty years before and mild diabetes for twenty years.

The patient was obese and did not appear acutely ill. The abdomen was full but there was little distention. It was soft to palpation, with only slight tenderness on deep pressure to the right of the umbilicus. Roentgenologic examination disclosed a dilated loop of small bowel, and ingestion of a small amount of barium mixture revealed the obstruction to be in the midportion of the small bowel.

Laparotomy disclosed that the obstruction which was in the midileum due to an impacted large gallstone. A resection of the involved segment of the bowel with side to side anastomosis was performed. The gallbladder was palpated gently and the absence of an acute inflammatory reaction was noted. Particular care was taken to avoid separating any adhesions.

The patient's condition was quite satisfactory the day following operation but thirty-six hours after operation the temperature rose to 107° F. Her condition became rapidly worse and death occurred forty-eight hours after operation. Autopsy which was limited to the abdominal cavity revealed the anastomosis intact and the intestine not greatly dilated. The fistula was cholecystoduodenal but was almost obliterated. There was also a recent perforation of the gallbladder into the general peritoneal cavity producing peritonitis, and gallstones were found free in the peritoneal cavity.

Comment—This case illustrates the danger of progression of the inflammation in the gallbladder with resultant perforation. While the patient's condition was not considered serious at operation it was thought wise not to disturb the gallbladder then and to provide for later operation. If a drain had been introduced into the region of the gallbladder death might have been avoided. Gallstones were still present in the gallbladder as is noted in the majority of such cases.

Case II—A woman aged 48 years, was admitted to the hospital on December 8, 1939 for treatment of an orthopedic condition of the leg. On December 14 she was a suddenly severe pain in the lower abdomen. Nausea and vomiting followed. The cramplike pains persisted and violent. Further questioning revealed a history of a similar attack a year before and also a gallbladder attack fifteen years before.

On examination the abdomen was soft and relaxed and there was a tenderness in the left upper quadrant and tenderness in the right lower quadrant. The leukocyte count was 19,000. With the tenderness in the right lower quadrant increasing laparotomy was advised and performed through a low right rectus incision. A loop of distal jejunum was adherent to the anterior abdominal wall at the attachment beginning to the right of the midline and extending well to the left. The proximal loop was tensioned and some flat dusky but viable. The obstruction was due to a faceted gallstone 5 cm. by 2 cm. impacted just proximal to the segment of angulated and adherent ileum (Fig. 5). This stone was removed through a longitudinal incision made in the normal segment of bowel below the obstruction. The incision was closed transversely to avoid narrowing of the lumen of the bowel. The gallbladder which contained stones was adherent to the duodenum and covered by omentum. Cholecystostomy was performed removing five large stones 1 to 3 cm. in diameter.

The postoperative progress was good for several days but then she began to show the ill effects of marked loss of bile and duodenal contents through the biliary and communication duodenal fistula. A Levin tube was introduced through the nose and successfully passed into the duodenum past the fistulous opening. Suction was maintained in the external fistulous tract and the drainage was reintroduced into the intestinal tract through the Levin tube. The subsequent progress of the patient was uneventful and the fistula was closed with satisfactory wound healing.

Comment—Again the history of gallbladder disease was obtained and stones were found in a gallbladder which had established a fistulous communication with the duodenum. Early operation successfully relieved the intestinal obstruction and aside from a transient duodenal communication to the exterior abdomen the patient made a satisfactory recovery. Cholecystectomy should be performed later in such a case.

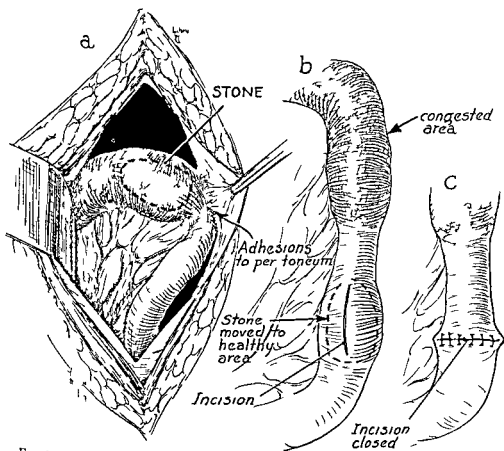


Fig 252—*a* This drawing illustrates intestinal obstruction produced by a gall stone impacted at a point of narrowing in the jejunum. The reduction in the caliber of the small bowel was due to adherence of a segment of the bowel to the anterior abdominal wall from adhesions *b* and *c*. The gallstone is worked past the point of impingement into the normal intestine and is removed through a longitudinal incision which is then closed transversely. Resection was unnecessary in this case (Colcock B P Lahey Clin Bull 2:47-52 [Oct] 1940).

CASE III—A woman aged 67 years was admitted to the hospital on January 8, 1944. She had had nausea and vomiting for five days without bowel movement or noticeable passage of gas by rectum during this time. She had also noted moderate abdominal distention.

The temperature and pulse rate were normal. The abdomen was slightly distended with some tenderness upon deep palpation in the right lower quadrant. Roentgenologic examination showed dilatation of the small bowel due to gas and an opaque body in the region of the gallbladder and a much larger calcified body

in the right lower quadrant (Fig 253). Following a barium enema a small amount of barium entered the ileum and encircled the area of calcification previously noted on flat plate of the abdomen. Peculiarly enough following the barium enema all symptoms were relieved and the patient's distention decreased with the passage of flatus.

A diagnosis of obstruction due to gallstone in the terminal ileum was suggested from the roentgenogram and operation was advised. Laparotomy through a right rectus incision revealed moderate edema of the terminal ileum and ileocecal



Fig 253—Roentgenogram of the abdomen. Note the flattening of the terminal ileum. A ring of calcification in the right iliocecal junction of the gallbladder is shown as well as a large filling in the right iliocecal junction. The roentgenogram suggests obstruction due to a gallstone in the terminal ileum. The gallbladder is firm.

al at a gallstone which apparently had been impacted at the ileocecal junction. The symptoms of obstruction were found in the cecum. Apparently the barium enema had lodged it from the ileocecal valve and the stone being long had passed into the cecal lumen. Obviously it removed from the cecum as unnecessary and it passed later in the stool. Since the patient's condition was such that no bowel surgery was necessary, cholecystectomy was performed. A fistulous connection was found between the fundus of the gallbladder and duodenum. The gallbladder contained one stone smaller size and shape to the one in the lumen. It measured 5 cm by 3 cm and had a faceted surface.

at one extremity. The fistulous opening into the duodenum was closed with silk sutures and drainage of the area was instituted. The patient made an uneventful recovery without purulent drainage and without developing a duodenal fistula.

Comment—This patient developed a transient intestinal obstruction due to a gallstone which was accompanied by severe abdominal pain. Spontaneous relief of the obstruction followed the passage of the stone through the ileocecal valve. The proper diagnosis was suggested by roentgenogram and was confirmed by operation. Cholecystectomy was undertaken with closure of the duodenal opening. The gallbladder once more was found not to have emptied its entire stone contents into the intestine.

SUMMARY

Intestinal obstruction due to a gallstone impacted in the bowel is infrequent but does occur often enough to warrant its consideration in the diagnosis of acute small bowel obstruction. This is a serious complication of cholelithiasis and reports indicate that about 2 per cent of cases of intestinal obstruction are caused by a gallstone in the small bowel.

Three cases of intestinal obstruction due to a gallstone all occurring in elderly women are reported. Our experience that this complication usually occurs in elderly women is in accord with reports in the literature.

The mortality can be reduced only by early diagnosis and operation. The type of operation should be consistent with the patient's general condition. The fact that other gallstones may be present either in the gallbladder or in other segments of the bowel should be recognized. Surgery directed at the gallbladder disease should be undertaken either at once or at a subsequent operation depending upon the patient's general condition.

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INDICATIONS FOR COLECTOMY IN ULCERATIVE COLITIS

RICHARD B. CATTELL

At the Lahey Clinic all patients with idiopathic ulcerative colitis are treated medically unless their condition becomes unsatisfactory. Kieffer³ found in following up our patients that 45 per cent had an unsatisfactory result either because of failure to respond to treatment or because of exacerbation or recurrence of symptoms.

As I previously have pointed out¹ surgery can accomplish two things: namely, divert the intestinal content to the abdominal wall, putting portions or all of the large intestine at rest and remove portions or all of the involved intestine. At the Lahey Clinic three surgical procedures are utilized in these cases: (1) ileostomy, (2) partial colectomy, and (3) complete colectomy.

Ileostomy has been performed in over 100 patients. The result may be complete clinical remission of symptoms and healing of the ulcerations in the colon. In this case the following two subsequent courses are considered:

In a few selected cases the ileostomy can be taken down with end to end anastomosis of the ileum. Three factors are essential for success in closure of an ileostomy:

1. A clinical remission of symptoms without recurrence must have been maintained for twelve months.
2. Sigmoidoscopic examination must show disappearance of all ulceration. The mucosal surface may be granular and may bleed on manipulation and still offer no contraindication to closure.
3. The intestine is observed both proctoscopically and by barium enema should have flexibility and some haustral markings.

A larger proportion of patients with a satisfactory result following ileostomy should continue with a permanent ileostomy. This group of patients has complete relief of symptoms but on visualization of the large intestine following a barium enema too much contraction is present to permit closure. Not all patients with an ileostomy require colectomy; yet in our experience over half of those surviving ileostomy continue to have symptoms necessitating removal of the colon.

INDICATIONS FOR COLECTOMY

Colectomy is justified not only because it so frequently is a life saving procedure but also because the postoperative state is consistent with a useful and productive life. Although it irrevocably forces the acceptance of a permanent ileostomy at the same time it guarantees freedom from the primary and secondary effects of the infected colon.

Our indications for colectomy based on experience with the procedure in over 60 patients are as follows

Medical failure

Acute fulminating type

Chronic type

Obstruction

Subacute perforation abscess and fistula

Hemorrhage

Arthritis

Polyposis

Malignant degeneration

Medical Failure—Colectomy is advisable for the patient with an unsatisfactory result following ileostomy and subsequent medical treatment. If the patient remains incapacitated because of fever, malnutrition and rectal discharges and is unable to lead a reasonably active life, removal of the colon is the only thing that will lead to rehabilitation. Either partial or complete colectomy is a heroic but unjustifiable procedure in the acute fulminating case. Unless by ileostomy the patient is able to overcome the acute phase of the disease and enter a chronic phase, colectomy cannot be successfully applied.

Patients with the following conditions indicating colectomy might be considered failures from the standpoint of medical treatment but these are local complications in the bowel for which the colectomy is performed rather than the general or systemic manifestations of the disease such as fever and malnutrition.

Obstruction—Some patients respond satisfactorily to ileostomy yet because of cicatricial changes incidental to healing of the ulcerations narrowing of the lumen and obstruction may occur and necessitate colectomy. Following ileostomy or a complete ileac fistula even with a normal colon there is marked contraction of the entire large intestine as demonstrated by barium enema. The diminution in the caliber of the colon is due solely to disuse and lack of function.

If there is serious contraction or diminution in the lumen of the colon prior to ileostomy, actual obstruction may occur afterward. The patient who is apt to develop this complication sometimes can be recognized previous to ileostomy by observation of the colon following barium enema. When a sausage like segmental formation or lead pipe colon exists, stricture formation may result at the narrow areas. In these cases the decision for total colectomy can be made previous to ileostomy. With the knowledge that such a colon can never carry out a reasonable function, colectomy can be performed within a few months after ileostomy so as to limit the period of disability.

In an occasional patient with long standing ulcerative colitis in whom the active infection has completely disappeared, serious large bowel obstruction subsequently develops. Two of our patients had a segmental form of the disease limited to the sigmoid rectosigmoid

and rectum with the proximal colon gradually distending to a diameter of 4 to 6 inches. Obviously colostomy was necessary for the relief of obstruction and in order to prevent recurrence of the disease and involvement of the remainder of the colon abdominal perineal resection was carried out. This is probably an infrequent indication for colectomy.

Perforation Abscess and Fistula—Free perforation into the general peritoneal cavity which is a frequent cause of death in acute ulcerative colitis is not an indication for colectomy. We often have seen this complication at autopsy and until recently we thought it as invariably fatal. Two of our patients with this complication recovered. One had a proctotomy with drainage of nearly 1000 cc. of pus. In the other the infection was walled off and absorbed under medical management with the aid of sulfadiazine.

Subcutaneous perforation and abscess are common complications and usually necessitate subsequent colectomy.

Fortunately there is less tendency for multiple small and large fistulas in ulcerative colitis than in regional ileitis. The fistulas that we have seen usually have been in the left lower quadrant pointing to the groin or through the bladder, vagina, ischio-rectal fossa or perineum. The resulting fistulas and sinuses make subsequent colectomy necessary.

Anorectal complications in ulcerative colitis are frequent. Occur in over 20 per cent. Anal fissure is the most frequent and fistula in ano is the next most frequent. Local anorectal surgery is usually not advisable unless some degree of anal dilatation which can be accomplished by pectenotomy or division of the superficial bundle of the external sphincter muscle is performed.

If operation other than this is carried out for hemorrhoids, fissure or fistula the wound will remain open, the result will be unsatisfactory and fecal incontinence will be a frequent sequela. These patients are much better off with an ileostomy and total colectomy than a distressing discharge or incontinence.

A vesical fistula usually will heal promptly after colectomy if either a suprapubic or indwelling urethral catheter is kept in place for a time. Some of the most satisfactory results obtained following colectomy are in patients with a recurrent abscess or persistent fistula.

Hemorrhage—A persistent discharge of blood from the rectum may be a sufficient indication for colectomy. Massive hemorrhage occurs in a small percentage of cases. During the acute state the patient should be carried along on whole blood transfusions and medical treatment. As many as twenty-six transfusions have been given over a short period of time. In our experience an attempt to stop the hemorrhage by colectomy resulted fatally and resection during an interval of relative freedom from bleeding is preferable. Patients with hemorrhage as the predominant symptom should first have the ab-

dominoperineal portion of the procedure since this segment of the large intestine is more apt to give rise to massive bleeding

Arthritis—Failure of medical treatment in ulcerative colitis may result in an acute or chronic infectious arthritis. Roentgenograms of the joints show little except change in the soft parts with considerable periarticular swelling and painful and limited motion. Patients may become completely incapacitated and may be unable to feed themselves or take any part in their own care. If the condition is allowed to persist, marked muscular atrophy, irreversible joint change and permanent incapacity result. Colectomy certainly should be performed after a short period of trial of other treatment. Except in the patient with marked muscular atrophy and joint change, the symptoms may disappear as early as three or four weeks after colectomy with rapid resumption of good joint motion.

Polyposis—A pseudopolypoid change may be a complication if the ulcerations are deep and confluent. The deeper ulcerations tend to follow the longitudinal bands of the colon and the mucosa between the linear confluent ulcerations may become very shaggy and polypoid in appearance. Areas of mucosa may become undermined so that there is mucosal bridging that may involve large areas. Occasionally healing occurs between opposite walls of the mucosal surface where contracture and adherence result in bridging the lumen. A severe degree of polypoid change which is best demonstrated by proctoscopic examination and an air contrast enema precludes the possibility of reasonable bowel function; is an irreversible state and if accompanied by symptoms indicates the necessity of colectomy.

Malignant Degeneration—For a number of years our observation indicated that malignancy was a rare development on the basis of chronic ulcerative colitis. However, in the last two years we have observed 8 patients with carcinoma arising in ulcerative colitis and previous to this period 3 additional patients had been seen. At present we believe that malignancy, while somewhat rare, is most frequent in patients who have had ulcerative colitis for over five years. We have been following patients carefully for the last fifteen years and in those who have had symptoms for a long time an increasing incidence of carcinoma has been noted.

Carcinoma on the basis of ulcerative colitis is of an extremely malignant character and is usually inoperable because of generalized abdominal metastases. For this reason any patient with ulcerative colitis, either with or without ileostomy, who after a barium enema has a persisting filling defect suggestive of malignancy, should be explored. If spread has not occurred, the most radical type of resection for malignancy of the large bowel should be performed.

Based on our more recent experience with malignancy in ulcerative colitis and because of its high grade and frequency of spread, early colectomy must be advised when the findings suggest beginning malignant degeneration.

SUMMARY

Colectomy for patients with ulcerative colitis is necessary when complications develop that are not amenable to medical relief. These complications are frequent recurrences, obstruction, perforation, hemorrhage, arthritis, polyposis and malignancy. Partial or total colectomy offers the only means of relief under these circumstances and is consistent with reasonable postoperative activity.

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TECHNIC OF TOTAL COLECTOMY FOR ULCERATIVE COLITIS

RICHARD B. CATTELL

TOTAL colectomy has been necessary in approximately 20 per cent of our patients with chronic ulcerative colitis. The indications for carrying out this procedure are discussed in the preceding paper. The operation which is of considerable magnitude is performed only after failure of medical treatment and because of serious complications.

Surgery of the colon in the presence of ulcerative colitis presents different problems from surgery for malignant disease. In the latter normal bowel is encountered at the limits of the resection so that some form of satisfactory anastomosis can be performed. When ulcerative colitis is present the bowel content is purulent and highly infective and the bowel wall is thickened, edematous and not amenable to suture. Furthermore the colon is not only foreshortened but also considerably contracted and the lumen is decreased. The peritoneal attachments of the colon in malignant disease are avascular whereas in ulcerative colitis there is capillary ingrowth to these attachments. Rarely is ulcerative colitis sufficiently limited or segmental in type to permit removal of limited portions of the large intestine without leaving infected bowel still present.

Total colectomy is carried out during the chronic stage of ulcerative colitis. Most of these patients are in poor condition because of weight loss, malnutrition, dehydration and anemia. They require careful evaluation and preoperative treatment to get them in the best possible condition for operation. Blood transfusions usually are required preoperatively and are always given during each stage of the colectomy.

Spinal anesthesia is used in all cases, usually employing 15 to 20 mg of pontocaine weighted with glucose solution. This anesthetic provides excellent relaxation, contraction of the small intestine and a quiet abdomen. A constant intravenous drip of saline or glucose solution is maintained throughout the procedure.

ILEOSTOMY

Ileostomy rarely should be accompanied by removal of a portion of the colon. This procedure usually is carried out at the time when the patient is in the poorest possible condition. Rarely is ileostomy advised until the patient has failed to respond to medical measures which are apt to be continued far beyond possible benefit. A further delay may occur before the patient or his family is willing to accept ileostomy.

If the mortality following ileostomy is to be kept within reasonable limits it will be necessary to accept ileostomy earlier than at present. Ileostomy should be performed unless there is a favorable response to medical treatment within seven to ten days.

At the Lahey Clinic two types of ileostomy for ulcerative colitis are performed. In the double barrel type both the proximal and distal ileac loops are brought out through the same incision. In the divided type the proximal or functioning ileac loop is brought out through the lower right midrectus and the distal nonfunctioning loop is brought out through a stab incision outside of the rectus in the anterior axillary line above the level of the umbilicus.

The double barrel ileostomy is done on patients who are in such poor condition that the simplest satisfactory operation is advisable or on those who are in relatively good condition but are medical failures and there is some chance of restoring continuity by later taking down the ileostomy.

The divided type of ileostomy which was described in the *Surgical Clinics of North America* in 1939¹ is performed when total colectomy can be decided upon at the time of ileostomy. This type of ileostomy makes the first stage of the colonic resection somewhat simple since it is unnecessary to deal with a small blind loop of distal ileum.

A long interval between the ileostomy and colectomy is necessary to obtain maximum improvement. This also enables the patient to become familiar with handling the ileostomy and to become reconciled to it as a permanent necessity before the irrevocable step of removal of the colon. This long interval likewise permits sufficient observation by the surgeon to determine whether total colectomy is necessary. If colectomy is decided upon before the ileostomy is performed it can be carried out on a second hospital admission two to three months after ileostomy. In most patients however an interval of twelve months or more should elapse between ileostomy and colectomy.

The double barrel ileostomy is performed through a right rectus incision splitting the middle and inner thirds of the right rectus with the upper angle of the incision beginning at the level of the umbilicus. A small incision is sufficient. With the peritoneum opened the distal ileum is identified and the ileocecal region is observed but not palpated. No abdominal exploration should be carried out. This inspection of the right lower quadrant should determine whether the terminal ileum is involved by the ulcerative colitis. This occurs in approximately one sixth of cases.

The site of the ileostomy should be 4 to 8 inches from the ileocecal valve depending upon whether there is involvement. If there is a possibility of subsequently taking down the ileostomy it should be at least 6 inches from the ileocecal valve. If there is involvement of the terminal ileum the ileostomy should be placed proximal to this. If a divided ileostomy is to be done it will be necessary to select a point

4 to 6 inches from the ileocecal valve in order to permit mobility of the distal loop so that it may be implanted at a higher level

When the site for the ileostomy has been selected the vessels of the mesentery are carefully inspected. There are usually three arcades of vessels. A vertical incision is made in the visceral peritoneum on each side of the mesentery passing down over the first two arcades. The vessels then are secured individually so that the mesentery is not shortened by mass ligatures. With the ileomesentery divided and with an adequate blood supply demonstrated in both proximal and distal loops

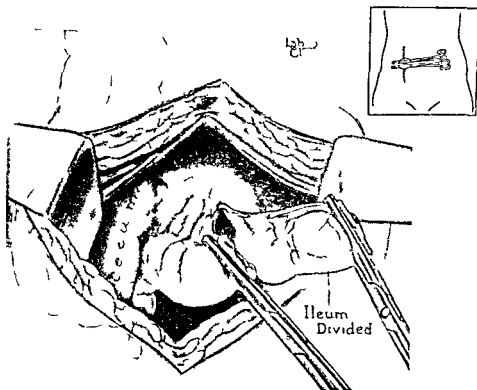


Fig 254—The double barrel type of ileostomy with both loops to be brought out through the same incision. The proximal loop on the right will be brought out below the distal loop. The ileomesentery and the ileum have been divided with the abdomen open in order to permit satisfactory anchoring of the loops.

there is satisfactory mobility to both proximal and distal ends of the ileum (Fig 254). Both loops are brought through the incision with the functioning proximal loop in the inferior position. The peritoneum of the anterior abdominal wall is sutured to the peritoneum of the ileomesentery to prevent prolapse. Any sutures to the ileum itself must be avoided for it is almost certain to be followed by an ileic fistula at the point of suture. The functioning loop is withdrawn so that it projects 1.5 inches beyond the skin level while the distal upper loop projects 0.5 inch (Fig 254 inset).

The technic of the divided ileostomy will not be described further since it has been presented in detail elsewhere.¹

A single loop ileostomy never has been employed at the Laker Clinic since we consider it hazardous. The first stage of the colectomy unquestionably is made easier since the ileum readily is freed up from within the peritoneal cavity when the distal loop has been inverted and

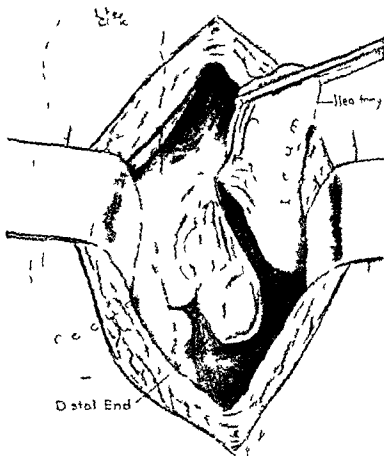


Fig. 55—This type of ileostomy with the distal end inverted should not be used.

dropped inside (Fig. 255). If the colectomy is to be done within a short time the risk is decreased. As soon as any type of ileostomy is done the colon tends to contract and if it already has a decreased lumen a real obstruction may develop causing the blind loop of ileum to blow out or it might result in perforation of the colon. Based on our experience we believe the divided type of ileostomy has similar advantages without the increased hazard.

TOTAL COLECTOMY FIRST STAGE

In most of our patients we have resected the right colon or right colon and transverse colon as the first stage of the removal. The abdominal perineal portion is performed first in patients in whom hemorrhage is the indication for operation or in those in whom malignancy in the lower segment is superimposed on the ulcerative colitis. Rarely the patient's condition is so poor that only the right colon is removed (Fig 256 inset). In 1 patient three different resections were per-

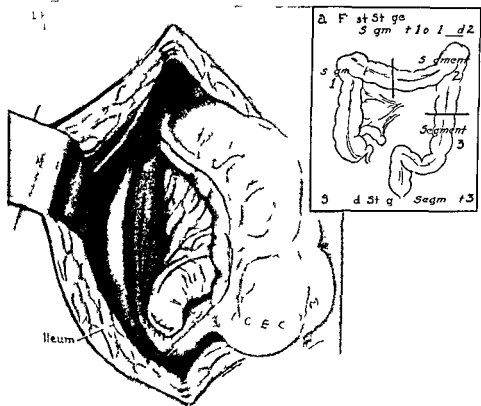


Fig 256—The cecum and ascending colon have been freed by division of the lateral peritoneal attachment. Inset The outline of the colon showing the limits of resection of the first and second stage.

formed but in the remainder in whom the right colon resection was the first stage the remainder of the colon including the rectum was removed as the second stage. A routine first stage resection is removal of the terminal ileum, right colon, transverse colon, splenic flexure, and the first portion of the descending colon (Fig 256 inset segments 1 and 2). Our early resections were performed through a right rectus incision but for the last five years we have made a subcostal incision which permits satisfactory access to the right lower quadrant as well as to the splenic flexure.

If a double barrel ileostomy has been done it is necessary to free up the ileocecal region and divide the ileum an inch or two below the peritoneum turning in the proximal end. This leaves a small blind ileac segment with an opening at the ileostomy. If a divided ileostomy has been performed the implanted loop is included in the subcostal incision, so that it can be freed up without difficulty.

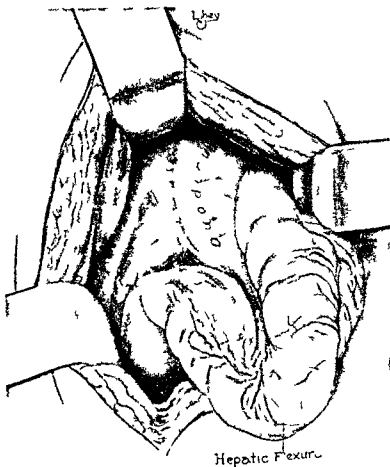


Fig. 257—The hepatic flexure has been detached and dropped and the descending colon has been exposed.

In the first stage operation the cecum and ascending colon are freed up by dividing the parietal peritoneum. Ligation of many vessels in these attachments being necessary (Fig. 256). The contraction of the bowel, particularly after long standing ileostomy, is such that the hepatic flexure is drawn down and the entire right colon rarely measures over 6 to 8 inches. The hepatic flexure is next freed and the entire right colon is elevated so that the mesocolon can be inspected (Fig.

257) No attempt is made to remove all of the glands in this area. As much of the mesocolon as possible is saved so that the right side of the abdomen can be peritonized with it. Resection of the right mesocolon does not need to be as complete as for malignancy.

We have found it impossible to save the omentum. The inflammatory process causes unusual adherence of the anterior two layers of the omentum to the transverse colon. Following detachment of the hepatic flexure the anterior two layers of the gastrocolic omentum

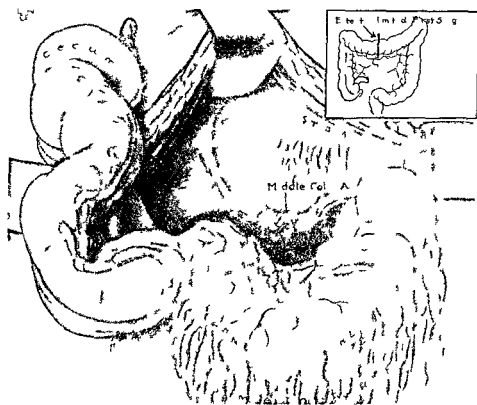


Fig 258—The cecum, ascending colon and hepatic flexure are free and the dissection is continued through all four layers of the gastrocolic omentum, ligating the branches of the middle colic artery. The greater omentum is left on the specimen. Inset: In poor risk patients the first stage may be stopped at the transverse colon.

are separated and this structure is divided 1 to 1.5 inches below the stomach (Fig 258). The posterior two layers can be identified and the middle colic artery ligated. The lesser omentum can then be reconstructed by suture of the anterior two layers to the posterior two layers of the gastrocolic ligament. It is best to do the peritonization as one proceeds with the resection so that it is unnecessary to regain the same exposure a second time. If a limited first stage is to be done (Fig 258 inset) the left half of the middle colic artery is not divided. If it is thought unwise to proceed further, a small stab incision is made in

If a double barrel ileostomy has been done it is necessary to free up the ileocecal region and divide the ileum an inch or two below the peritoneum turning in the proximal end. This leaves a small blind ileac segment with an opening at the ileostomy. If a divided ileostomy has been performed the implanted loop is included in the subcostal incision, so that it can be freed up without difficulty.

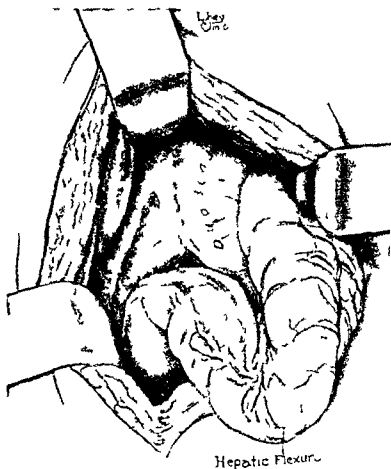


Fig. 257—The hepatic flexure is retracted and dropped and the greater omentum is reflected.

In the first stage operation the cecum and ascending colon are freed up by dividing the parietal peritoneum ligation of many vessels in these attachments being necessary (Fig. 256). The contraction of the bowel particularly after long standing ileostomy is such that the hepatic flexure is drawn down and the entire right colon rarely measures over 6 to 8 inches. The hepatic flexure is next freed and the entire right colon is elevated so that the mesocolon can be inspected (Fig. 257).

257) No attempt is made to remove all of the glands in this area. As much of the mesocolon as possible is saved so that the right side of the abdomen can be peritonized with it. Resection of the right mesocolon does not need to be as complete as for malignancy.

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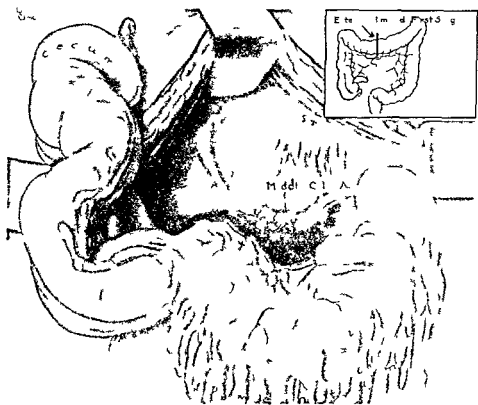


Fig 258—The cecum, ascending colon and hepatic flexure are free and the dissection is continued through all four layers of the gastrocolic omentum ligating the branches of the middle colic artery. The greater omentum is left on the specimen. Inset: In poor risk patients the first stage may be stopped at the midtransverse colon.

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the left rectus muscle and the distal end of the colon is drawn out through this opening. Usually the resection is continued to include the splenic flexure and descending colon.

It is not difficult to detach the splenic flexure through a right subcostal incision under the satisfactory operating conditions that spinal anesthesia offers. It would be difficult to free a splenic flexure that was not constricted. By elevation of the abdominal wall and pressing down on the splenic flexure (Fig. 759) one can detach the peritoneum and secure the vessels in this area passing upward to the stomach and spleen. As soon as the splenic flexure is detached and drawn to the right, the

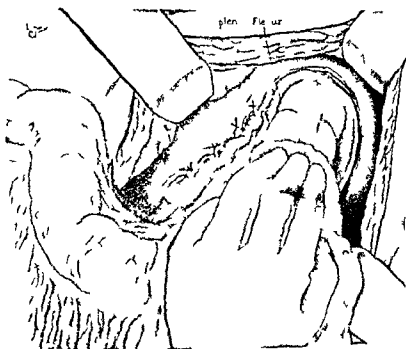


Fig. 759—The splenic flexure being detached by elevation of the peritoneal attachment.

peritoneal attachment of the descending colon is put on the stretch and can be divided either bluntly or by scissors dissection. The left colic artery is left intact but the anastomotic branch with the middle colic artery is divided.

A stab incision is made in the left rectus muscle which will be in a position to occupy the upper end of the incision for the next stage of the colectomy (Fig. 760). A curved Ochsner clamp is useful for this purpose. The bowel can be drawn over into the right incision and divided by cautery, the specimen removed and the distal loop implanted. No attempt should be made to invert the end of the bowel nor should it be left within the peritoneal cavity. The stab incision

is closed in layers loosely about the implanted loop and the original incision closed without drainage. No attempt is made to peritonize the left lumbar region. Blood transfusion is given routinely either during or at the conclusion of this resection.

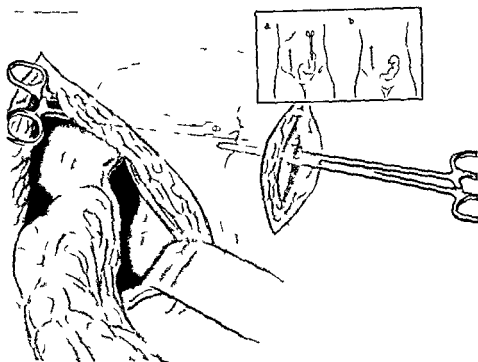


Fig. 60—A stab wound has been made through the left rectus muscle and a clamp has been passed in to grasp the bowel distally. The proximal clamp is placed through the original incision. *Inset a* The loop has been implanted with the bowel projecting beyond the skin. *Inset b* The bowel should not be inverted and left within the peritoneal cavity.

The patient remains in the hospital from fifteen to twenty days. No irrigation of the remaining loop is given. A moderate amount of discharge occurs from the implanted loop and a somewhat decreased rectal discharge is present.

TOTAL COLECTOMY SECOND STAGE (ABDOMINOPERINEAL RESECTION)

The second stage of the resection should be delayed for two or three months. We have made it a rule to do an abdominoperineal resection in every colectomy. This segment of the bowel usually shows the worst involvement and always should be removed. Dramatic improvement is not unusual after the first stage and there may be a temptation not to remove the distal bowel.

The implanted loop is sutured and a left rectus incision is made detaching the implanted loop (Fig. 261 inset). The peritoneal attachment of the descending colon and sigmoid is severed and the meso-sigmoid is freed up (Fig. 261). Most of the mesocolon can be left after

ligating the left colic and sigmoidal vessels. Reperitonization of this portion of the operative field is performed before the dissection of the pelvis.

Incision of the pelvic peritoneum can be made well medial to the ureters on each side and close to the bowel. Little of the peritoneum of the pelvis need be sacrificed. The superior hemorrhoidal arteries are tied well over the pelvic brim (Fig. 767) and pelvic dissection of the

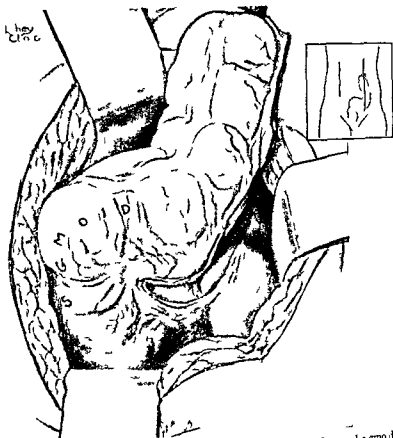


Fig. 61—The peritoneal attachment of the descending colon and sigmoid has been severed preparatory to dividing the mesosigmoid. Inset: The mesosigmoid has been sutured.

rectum is performed bluntly, similar to the dissection for carcinoma of the rectum. Because of the increased vascularity associated with the infection, it is usually best to ligate the middle hemorrhoidal pedicles to decrease bleeding. The dissection is carried down posteriorly well beyond the tip of the coccyx, and the deep pelvic fascia is cut at this level, exposing the levator muscles on each side. If a large segment of descending colon remains, it is necessary to remove a portion of the bowel before reducing the remaining segment. The rectos.

moid can then be reduced into the pelvis by turning it back on itself (Fig 262 *a*) It is held in place by a gauze sponge (Fig 262 *b*) which is removed through the perineal incision

Freeing up the pelvic peritoneal flaps in the abdominoperineal resection for ulcerative colitis is rarely much of a problem The superior hemorrhoidal vessel stumps are carefully covered by peritoneum and

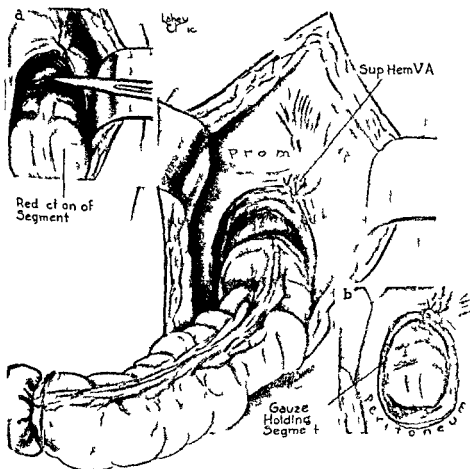


Fig 262.—The pelvic peritoneum has been incised on both sides and the superior hemorrhoidal vessels have been ligated and divided *Inset a* The remaining rectosigmoid segment is being reduced into the presacral space *Inset b* The bowel segment is held in place by a gauze sponge

the flaps are sutured together as they fall naturally (Fig 263) It is rarely necessary to use the uterus or omentum to reinforce this suture line (Fig 263 *inset*) Most women patients who have a total colectomy should be sterilized by tubal division since they are in the childbearing age This point always should be discussed with the patient and a decision reached before operation is undertaken If the patient is not sterilized she should be advised that if pregnancy occurs a cesarean section is advisable

The abdominal incision is closed without drainage and is walled off to avoid contamination by the discharge from the ileostomy.

The patient is then placed on the left side in a modified Sims position and the anus is closed. Perineal dissection frequently is complicated by anorectal lesions that occur so commonly with ulcerative

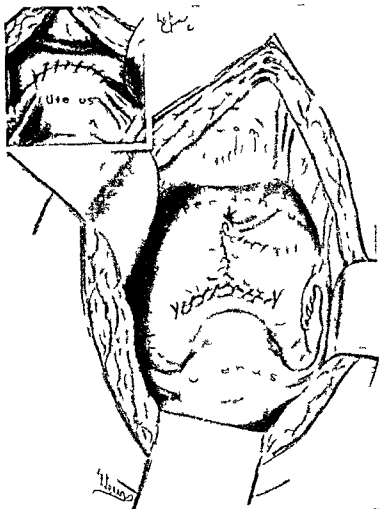


Fig. 263—The pelvic peritoneum is restored by sutures. Insert: This perineal suture line may be reinforced by the fundus of the uterus or by omentum.

colitis. Tissue fistula in ano, vaginal fistula and ischio-rectal abscess are common. An elliptical incision is made incising as much of the infected skin as possible. It is rarely necessary to remove the coccyx. A transverse incision is made below the coccyx entering the presacral space and the segment of bowel is delivered (Fig. 264). The levator muscles can be put on the stretch over the finger and divided close to the

bowel It is a simple matter to detach the segment from the transversus perinei vagina or prostate A small drain is placed in the lower pelvic space and the incision is closed in layers around it No pack is inserted Sulfonamide drugs are used only if infection is present outside

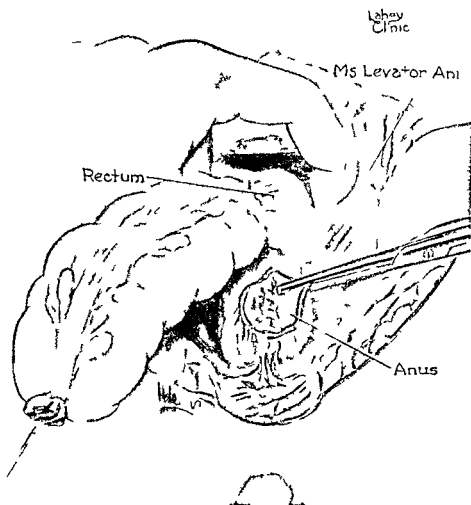


Fig 264—The segment of bowel has been delivered from the pelvis and the attachment of the levator muscles is being freed up and divided

of the bowel or perforation of the bowel occurs during removal Transfusion is given at the conclusion of the resection All patients are placed on closed bladder drainage for a period of a week

COMMENT

In the last twelve years over 100 ileostomies have been done for ulcerative colitis at the Lahey Clinic When ileostomy has not given satisfactory relief total colectomy has been carried out by the technique outlined Over 50 total colectomies have been performed with 7 deaths

Based on our experience we believe that colectomy should be done during the chronic stage of the disease and not during acute exacerbations.

It is important to divide the operation of total colectomy into stages the amount to be removed depending upon the condition of the patient. A sufficient interval should elapse between the first and second stage to permit the improvement that will occur as the result of the first stage. No blind loops of either ileum or colon should be left within the peritoneal cavity or peritonitis will almost certainly follow. No attempt should be made to suture infected bowel.

If these recommendations are followed the operative risk will be minimized and a high percentage of satisfactory results will follow.

SUMMARY

The double barrel and divided types of ileostomy are discussed.

The technic of total colectomy performed in two stages following ileostomy is presented.

REFERENCE

1. Cattell, R. B. A New Type of Ileostomy for Chronic Ulcerative Colitis. *S. CLIN. NORTH AMERICA* 19:69-636 (June) 1939.

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1. Catell, R. B. A New Type of Ileostomy for Chronic Ulcerative Colitis. *S. CLIN. NORTH AMERICA* 1966 9-616 (June) 1939.

THE MANAGEMENT OF GASTRO INTESTINAL HEMORRHAGE

Report of a Case

JOHN W. NORCROSS AND RICHARD B. CATTELL

It is essential to bear in mind the various causes of gastro intestinal bleeding if we are to meet the problem of its control intelligently. While the scope of this paper does not permit a detailed discussion of all the possible etiologic factors that may be involved in such a hemorrhage some of the more important causes are outlined.

Among the most important causes of obscure gastro intestinal blood loss are congenital structural abnormalities including hemangiomas of the intestinal wall, generalized varices of large areas of the intestine, hereditary hemorrhagic telangiectasia and Meckel's diverticulum. A peptic ulcer in the gastric mucosa or in the duodenum is a common source of bleeding and occasionally this lesion also may be found in the esophagus or in a Meckel's diverticulum.

The acute fevers may cause a decrease in capillary resistance of such a degree as to promote some bleeding into the gastro intestinal tract, and gross hemorrhage commonly occurs in typhoid fever. Moderate blood loss is frequent in acute bacillary and amebic dysentery as well as in tuberculous enteritis and regional enteritis. Regional or segmental ulcerative colitis of the nonspecific type may be responsible for blood loss at a stage when proctoscopy and barium enema are negative.

Blood dyscrasia may be responsible for blood loss in any part of the body, especially if some other lesion is present to initiate the bleeding. Thus leukemias, myelophthisic states, hereditary thrombopathy and hemophilia must be considered in studying intestinal blood loss. Purpura of both the thrombocytopenic and nonthrombocytopenic types also comes under this general heading. Occasionally massive intestinal bleeding is due to anaphylactoid purpura of the Henoch's variety.

Tumors of the gastro intestinal tract, both benign and malignant including polyp, lymphoma, carcinoma and sarcoma are common bleeding sources. Bleeding gums are often the cause of occult blood in the stools. Varices in the esophagus or stomach may arise from congestive splenomegaly or cirrhosis of the liver and result in vicious and often fatal hemorrhage. Hemorrhoids are an obvious source of blood loss but must not be confused with other more important causes which may coexist.

Avitaminosis C leads to scurvy when there is a marked increase in capillary fragility and avitaminosis K and hypoprothrombinemia if of severe degree leads to blood loss from many parts of the body.

Based on our experience we believe that colectomy should be done during the chronic stage of the disease and not during acute exacerbations.

It is important to divide the operation of total colectomy into stages, the amount to be removed depending upon the condition of the patient. A sufficient interval should elapse between the first and second stage to permit the improvement that will occur as the result of the first stage. No blind loops of either ileum or colon should be left within the peritoneal cavity or peritonitis will almost certainly follow. No attempt should be made to suture infected bowel.

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1. Cattell, R. B. A New Type of Ileostomy for Chronic Ulcerative Colitis. *S. CLIN. NORTH AMERICA*, 1969-636 (June) 1939.

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SUMMARY

The double barrel and divided types of ileostomy are discussed.

The technic of total colectomy performed in two stages followed by ileostomy is presented.

REFERENCE

1. Cattell R. B.: A New Type of Ileostomy for Chronic Ulcerative Colitis. *S. CLIN. NORTH AFRICA* 19(9-636) (June) 1939.

Eight days after admission the abdomen was explored and the entire gastro intestinal tract was carefully examined. No abnormality other than adhesions from the previous operation was found. A normal appendix was removed.

The patient continued to bleed and received three transfusions in the course of three days. In view of the type of bleeding it was felt that it must be coming from no higher than the terminal ileum and an operation was devised whereby exact observation of the entire colonic mucous membrane could be carried out at the time of bleeding. Thus one month after admission a Mikulicz colostomy was done in the midtransverse colon.

Following this procedure blood was seen to be coming from the proximal loop of the colostomy and the sigmoidoscope was passed to the cecum from which large amounts of gross blood were withdrawn but no bleeding points were seen. The patient received five transfusions in the course of twenty four hours and his condition was critical. Abdominal exploration again was carried out and blood was found in the cecum and in the last few inches of the terminal ileum. The last 19 cm of the ileum and 6 cm of the cecum were resected and a side to side anastomosis between the ileum and the distal end of the colostomy was performed.

No further bleeding occurred and a month later the colostomy and the stump of the transverse colon were closed. To date there has been no blood loss and the patient has remained well.

On pathologic examination the lower 10 cm of the ileum and the cecum showed submucosal hemorrhagic foci especially at the lower end of the ileum. Two cm proximal to the ileocecal valve a superficial ulceration was seen. Microscopically the typical lesion of regional ileitis was disclosed.

DISCUSSION

This case presented a difficult problem in diagnosis. All the usual procedures failed to throw any light on the etiology. For this reason and because repeated laparotomies had failed to show the lesion special measures had to be adopted to localize the site of bleeding. The type of bleeding with clots and without tarry stools gave an important clue and tended to localize the source to a point somewhere below the last foot or two of ileum. The colostomy judiciously placed allowed localization of the bleeding above the midtransverse colon and permitted visualization of the mucosa of the proximal colon and the cecum by means of a sigmoidoscope. This made the terminal ileum the most likely place for the lesion and on reexploration all the small and large intestine in which blood was found was removed. The local lesion was not demonstrated by the surgeon on operation or in the opened specimen but was found by the pathologist.

SUMMARY

Some common sources of gastro intestinal bleeding are discussed. The importance of discovering the etiology of such bleeding is stressed. A case is presented in which certain measures were devised to help localize the bleeding lesion. The removal of a segment of ileum and right colon stopped the bleeding.

POSTOPERATIVE PERINEAL HERNIA FOLLOWING RESECTION OF THE RECTUM

Report of a Case

RICHARD B. CATTELL AND RAYMOND M. CUNNINGHAM

POSTOPERATIVE perineal hernia following resection of the rectum is rare. Only 2 cases have been reported in detail since 1925. However in a discussion of Yeomans¹⁰ paper on perineal hernia before the American Proctologic Society in 1937 4 additional cases were mentioned. At the Lahey Clinic we have recently encountered our first perineal hernia in over 800 resections for carcinoma of the rectum.

In a report of 200 cases of carcinoma of the rectum treated by perineal excision Lockhart Mummery⁶ gave a detailed account of his follow up studies but made no mention of perineal hernia. In Gabriel's book on *The Principles and Practice of Rectal Surgery* he describes several complications after excision of the rectum but also does not mention postoperative perineal hernia.

In 1918 Moschcowitz⁹ reviewed the literature and found only 28 cases of nonoperative perineal hernia. He remarked that since every hernia results primarily from a defect in intra abdominal or pelvic fascia which in turn is caused by the passage of blood vessels or a viscus it is surprising that hernia at the outlet of the pelvis is so rare especially since the rectum, urethra, vagina and a host of blood vessels pass in and out of the pelvis. It is still more surprising that postoperative perineal hernias are rarely seen especially after radical excision of the rectum with removal of the coccyx.

Yeomans¹⁰ reviewed the etiology of perineal and pudendal hernias and called attention to the weak point or space on each side of the pelvic diaphragm where the iliococcygeus portion of the levator does not overlap the central portion (pubococcygeus) but passes onward to fuse directly with the pubococcygeal and rectococcygeal raphe. This weak point is closed only by the pelvic or rectovesical fascia above and separated only by areolar tissue from the ischiorectal fascia below. A perineal hernia presents in the ischiorectal fossa posterior to the transversus perinei muscle. The boundaries of the internal ring are the broad ligament anteriorly, the uterosacral ligament and rectum medially and an imaginary line between the two sides of this angle.

Yeomans reported a case of postoperative perineal hernia four months after perineal excision of the rectum for cancer. He did not mention removal of the coccyx but since this is customary in perineal excision it was probably done. He repaired the hernia from within the pelvis. The internal ring was posterior to the broad ligament and

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just to the right of the pelvic colon. The sac was adherent to the perineal skin, was inverted by pressure upward on the perineum and obliterated by sutures. The atrophic uterus was suspended anteriorly. Nine months later at the time of publication of his report there was no recurrence. Yeomans remarked that of the many perineal excisions of the rectum for carcinoma that he had performed this was the only patient who developed a perineal hernia. He attributed its occurrence to the strain of persistent coughing due to chronic bronchitis.

The second case was reported by Frank and Colp¹ who removed the coccyx in doing a perineal excision for carcinoma of the rectum. Their patient also a woman required two operations for cure of the hernia. In the first procedure only the levator stumps were sutured together in the midline behind the vagina. The sac was not treated. The hernia promptly recurred. In the next procedure the sac was obliterated, the levators reapproximated and the hernia cured. Both procedures were done from below.

In the discussion following Yeomans' paper Hayden² who mentioned having had 2 cases remarked that it seems remarkable to most of us that we do not see more perineal hernias following resection of the rectum. He quoted D. F. Jones³ as saying that he had not seen a case in over 800 resections of the rectum for carcinoma.

In Hayden's 2 cases the hernia occurred within a year following a one stage abdominoperineal resection. No mention was made of the coccyx. No repair was attempted in either case because it didn't seem to us in either of these cases that it was worth while attempting a repair knowing how little material there must be in the pelvis to suture across the defect. Both patients were men and both were treated with external support.

In the same discussion T. L. Jones³ remarked that he had seen a perineal hernia only once in over 300 combined abdominoperineal operations. This hernia occurred in a woman nine months after a hysterectomy. She was treated with external support. No mention was made of the coccyx.

The fourth case in this discussion was reported by McKenney.⁴ The patient was a woman whose hernia appeared three months after a one stage abdominoperineal operation without removal of the coccyx. The hernia was repaired from below by sac ligation only because so little was left of structures necessary to form a firm pelvic floor. The hernia promptly recurred.

REPORT OF CASE

An unmarried woman aged 50 years was first seen at the Loh Clinic on June 17, 1935 because of rectal bleeding of seven months duration. A proctoscopic examination elsewhere the previous November had disclosed a large carcinoma of the rectum with many polyps. Examination of a biopsy specimen

confirmed the diagnosis of adenocarcinoma and the polyps were removed. Deep roentgen ray therapy 2890 r units was given during the following month. In February 1935 12 radium emanation seeds totaling 42.4 millicuries were implanted throughout the persisting lesion. The concluding note of the preceding medical history stated that the general condition of the patient was such that radical surgery might prove too much for her so deep roentgen ray treatment and implantation of radium were advised.

Examination of the rectum at the Lahey Clinic revealed an ulcer 1.5 inches in diameter with a central crater 1 inch above the anus on the posterior wall. The lesion appeared to be very adherent but no clinical evidence of metastases could be found.

On June 14 1935 a first stage Lahey resection was performed. There were no abdominal metastases. The second stage of the operation was performed on July 1. Considerable difficulty was encountered in freeing the cervix and upper vagina from the rectal segment. However the abdominal portion of the operation was accomplished satisfactorily including the reconstruction of a good pelvic peritoneal diaphragm. Because of the adherence of the rectal segment the coccyx was disarticulated and removed. The technical difficulty in completing the perineal part of the operation seemed related to the radiation treatment. The perineal wound was closed about a large cigaret drain.

The report on the tissue removed was radiation reaction with necrosis and ulceration and negative lymph nodes.

The patient's postoperative course was satisfactory except for a low grade infection of the urinary tract which responded to treatment. She had no cough and left the hospital with a clean granulating sinus tract in the perineal wound.

For the next eight years the patient remained under close observation and the follow up notes are of interest in connection with the subsequent development of a perineal hernia. She intermittently had difficulty in controlling the colostomy and was seen eight times during the first postoperative year. The perineal wound continued to drain for seventeen months although it was not otherwise troublesome.

During the next five years she was well except for transient attacks of abdominal cramps and difficulty in colostomy irrigations. In an attempt to relieve these complaints local plastic operations on the colostomy were carried out on March 31 1938 November 9 1939 and December 13 1941 with temporary relief. The abdominal pelvic and perineal findings remained negative.

In January 1943 because of further difficulty it was decided to move the colostomy upward by disengaging it and dropping the splenic flexure. Consequently on February 5 the colostomy was detached and the entire abdomen was explored with negative results. A small portion of ileum had herniated through a rent in the omentum. The colon was freed to create a stoma that projected for 2 inches beyond the skin. Two months later a barium enema was negative.

On June 9 1943 eight years after the abdominoperineal resection the patient reported a large bulge in the perineum which was larger on standing and produced definite pressure in this area. She had thought it necessary to apply support. A defect could be felt at the site of the coccygeal removal and loops of bowel could be felt spreading out under the perineal skin. Not until five months later did we realize that this perineal hernia was related to the difficulty with colostomy irrigations.

At operation on December 6, 1943 under spinal anesthesia the hernia was repaired from below. The peritoneal sac was adherent to the skin and was dissected away. Several loops of bowel were pushed upward and the sac was excised. The neck of the sac was at the level of the uterosacral ligaments and the mobile atrophic uterus was used to obliterate the hernial ring, suturing the uterus and broad ligaments to the posterior aspects of the uterosacral ligaments, that is, a posterior interposition of the uterus. The pelvic fascia was closed as a separate layer beneath the interposed structures. The subcutaneous layer was next approximated, followed by closure of the skin with a small Penrose drain. There was no evidence of local recurrence of the growth which had been removed eight and a half years previously.

The patient was allowed up on the thirteenth postoperative day and was discharged on the sixteenth day. One month later her condition was excellent with complete relief of symptoms. Colostomy irrigations were satisfactory for the first time. There was a strong perineal floor with no evidence of hernia.

DISCUSSION

Ten years ago we discontinued removal of the coccyx during abdominoperineal resections except for unusual circumstances such as bleeding, a small pelvic outlet or an unusually large tumor.

As late as 1939 Miles⁵ recommended removal of the coccyx during performance of the perineal part of the combined operation. This practice was also followed by Lockhart Mummery⁶ in England, and in this country by many surgeons as a direct result of the influence of these pioneers in rectal surgery.

In the case reported in this paper the coccyx was removed because of adherence of the rectal segment due to radiation therapy. Its removal definitely contributed to the development of the perineal hernia. For thirteen years it has been our custom to close the perineal wound about a small cigaret drain, the upper portion of which is placed at the level of the cervix or the seminal vesicles. With the coccyx in place the cervix and vagina or the vesicles and prostate gland fall back in contact with the coccyx or sacrum as soon as the drain is removed on the fourth postoperative day. On numerous occasions at subsequent abdominal explorations following abdominoperineal resections the late position of the pelvic peritoneal diaphragm has been confirmed. Similarly, on infrequent occasions the closure of the pelvic outlet by the structures mentioned has been demonstrated on exploration of the perineal wound for possible pelvic abscess. Again during operations for recurrence in the perineal wound the prostate gland and vesicles or vagina and cervix have been found against the coccyx.

On the basis of these clinical observations we believe that the presence of the coccyx accounts for the infrequency of perineal hernias. It is certainly true that the closure of the subcutaneous fat and skin

would not be sufficient to support the weight of the intra abdominal contents. Not only is removal of the coccyx unnecessary but also definitely undesirable and it is the principal predisposing factor in the development of perineal hernia.

SUMMARY

The scant literature on perineal hernia is reviewed. This complication following resection of the rectum is probably more frequent than reports in the literature indicate. Seven cases of postoperative perineal hernia are reviewed briefly including 1 seen at the Lahey Clinic.

A perineal hernia should be treated as any other hernia namely by excision and high ligation of the sac followed by obliteration of the hernial ring and closure of the pelvic fascia. In the female the uterus and cervix can be interposed to support the abdominal contents and to obliterate the hernial opening or ring.

Removal of the coccyx is rarely necessary in combined abdomino-perineal resection for carcinoma and when performed predisposes to perineal weakness or hernia.

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CLINICS ON OTHER SUBJECTS

CARCINOMA OF THE THORACIC ESOPHAGUS

Clinical Observations and Experiences with Twenty eight
Surgically Explored Cases

RAIPH ADAMS

INTRODUCTION

CANCER of the esophagus ranks fourth in frequency among malignant tumors occurring in males beyond the age of 20 years¹ and accounts for 8 per cent of the deaths from malignancy beyond the same age.² Certain cases have proved amenable to surgical therapy and at present successful surgical extirpation offers the only ray of hope to this forlorn group of patients. Traditional professional pessimism about the disease, late referral of patients for surgical treatment, inexperience of surgeons in the technical management of this extremely difficult problem, a high tendency to recurrence equal at least to that of carcinoma of the stomach or ovary, all contributed to failure in most of the early cases. However, the disease is becoming increasingly important surgically because of accumulating successful cases and patients will be coming earlier to surgical therapy. Although the results still are unsatisfactory, at least they have improved.

During such a developmental phase the evaluation of methods and immediate results has value; consequently the experience of the Lahey Clinic with carcinoma of the thoracic esophagus is being recorded.

We have established the diagnosis microscopically in 100 cases since July 1, 1937, when our first successfully resected case was admitted,¹⁻¹⁶ to December 31, 1943. In all but 28 the lesion was inoperable at the time of diagnosis because of extension, metastasis, poor general condition or advanced age. This report is concerned with the 28 surgically explored cases.

SYMPTOMATOLOGY AND DIAGNOSIS

The symptomatic onset is usually insidious. Some variation of dysphagia is by far the most common symptom. Other complaints include substernal oppression, regurgitation shortly after eating, differential ability to swallow liquids but not solids, epigastric distress immediately after eating, and a sensation of pressure in the suprasternal notch.

Weight loss almost always occurs but weight loss in itself is not a reliable indication of advanced disease because it may be secondary to obstruction by a small operable carcinoma or even in rare instances a benign tumor. Back pain however is of serious import implying deep ulceration around a growth or extension into the paravertebral structures. In a patient beyond 35 years of age any change at all in the normal act of swallowing should arouse sufficient suspicion to promote active diagnostic measures. Difficulty in swallowing should be regarded by the profession and the public in the same light as a lump in the breast.¹¹ In each instance haste to establish a diagnosis is equally imperative. A policy of watchful waiting must be abandoned before a majority of patients with dysphagia from esophageal carcinoma will undergo operation sufficiently early to receive benefit. In our group the usual duration of symptoms before hospitalization was between four and eight months.

A diagnosis of carcinoma can be confirmed or excluded promptly and accurately by following a definite routine with every patient who has any difficulty in swallowing. The first step is fluoroscopy with barium with observation in both the anterior posterior and the oblique views. If evidence of a lesion is found the next step is esophagoscopy and removal of a biopsy specimen if tumor tissue is seen. Although esophagoscopy is essential for confirmation of the diagnosis it does not necessarily show the full extent of malignancy because of the possibility of extension outward rather than inward or metastasis along the submucosal lymphatics. It therefore furnishes an almost final proof of diagnosis but is less conclusive as an indication of operability. Unfortunately esophageal obstruction whether from a benign tumor stricture or malignant disease may be almost complete and yet produce very few symptoms. Mosher¹² has stated that a patient with an esophagus with a diameter of only 4 mm. may have few symptoms.

PRELIMINARY PREPARATION

Allotment of a sufficiently long period in which to get the patient with carcinoma of the esophagus in the best possible preoperative condition is time well spent. As a rule these patients present problems of dehydration, emaciation, avitaminosis and virulent mouth organisms. Although few are able to take a diet of normal consistency when hospitalized in most instances a restorative program can be carried out successfully by oral administration of high caloric liquids with vitamin and amino acid and electrolyte supplements. Mouth hygiene should be enforced and blood transfusion should be given in the presence of secondary anemia.

Several times in spite of obstruction which prevented adequate intake by swallowing we have been able to pass a Levin tube through the obstruction caused by the tumor and feed the patient effectively. In former years we frequently resorted to enterostomy either gas

trostomy or jejunostomy for preliminary preparation, but recently have less often found it necessary. One advantage of preliminary enterostomy is that it provides a means of feeding the patient for the first week postoperatively but it has certain disadvantages also. First, a gastrostomy may complicate the mobilization and resection of the stomach although this has never been a serious factor. Secondly, patients should receive very little food for the first few days after a resection of this magnitude. If the operation is successful they will be able to take food orally after removal of the lower third of the esophagus or through the newly established gastric stoma after removal of the entire esophagus. Thirdly, the usefulness of jejunostomy is limited in duration and there is always some risk of intestinal obstruction around the adherent loop into which the catheter is inserted.

To attain surgical success in the treatment of carcinoma of the esophagus there are many dangers to be overcome other than those of a purely technical nature. In addition to those factors already mentioned the age, cardiovascular condition and body type are important. The fat short-necked barrel-chested emphysematous patient is a particularly poor risk. No patient has been excluded because of age alone, the youngest being 29 and the oldest 72, but it should be borne in mind that the ability of a patient beyond 60 to undergo surgery of such magnitude is often more markedly diminished than the general appearance suggests. Experience has taught us that patients with pain in the dorsal spine as a principal complaint are almost certain to have extension or metastasis which makes the lesion inoperable.

PATHOLOGY

The only two cell types we have encountered are epidermoid carcinoma and adenocarcinoma. In the 28 surgically explored cases, 16 had adenocarcinoma and 12 epidermoid carcinoma, but a large majority of the adenoma type undoubtedly represented spread upward from the cardia of the stomach. In fact a diagnosis of adenocarcinoma of the esophagus implies origin in gastric mucosa but not necessarily origin within the stomach itself. Islets of gastric mucosa occasionally are found in the lower portion of the true esophagus. One adenocarcinoma developed in an esophageal diverticulum and 3 adenocarcinomas were found within a diaphragmatic herniation.

The role of chronic irritation in connection with achalasia has been mentioned by others^{6,7} and in 1 case in this series an adenocarcinoma developed in the lower third of an esophagus that had been afflicted with cardiospasm for more than twenty years. It is doubtful whether such cases have statistical significance but it is of interest that practically all of the cases reported including our own had been submitted to possible chronic irritation (cardiospasm) for more than fifteen years. They thus support the empirical rule that carcinoma rarely develops at the site of chronic irritation such as an osteomyelitic sinus.

or chronic ulcer within a period of less than fifteen years although the development of malignancy in the scars of old burns is an exception

Our former belief that a short history meant probable operability has had to be modified somewhat. Two patients with symptoms of less than one month's duration had inoperable lesions at the time of exploration because of glandular metastases and they illustrate the notable tendency of carcinoma of the esophagus to extend along the submucosal lymphatics at a rapid rate and for a considerable distance. On the other hand the growth may remain localized for a considerable period of time as shown by 1 of our patients who had no signs of extension or metastasis after eleven months of dysphagia and is still well and working sixteen months after operation.

Metastasis into the nodes along the lesser curvature of the stomach beneath the diaphragm is frequent from carcinoma in the lower third and should be suspected in any lesion located below the midpoint of the thoracic esophagus. Lesions behind the left primary bronchus and the aortic arch are likely to extend directly into these structures and thus quickly limit operability. Recurrent left laryngeal nerve paralysis may be found in association with lesions in the upper third of the esophagus and supraclavicular glands become involved mainly from disease in this location.

ANESTHESIA

Expertly administered intratracheal anesthesia is a basic prerequisite to the surgeon who would classify his technical successes in this field as other than fortuitous accident. The anesthetic agent is secondary in importance to the competence of the anesthetist responsible not only for its administration but also in large part for the welfare of the patient during the operative procedure.

TECHNIC

All carcinomas of the esophagus would be operable if submitted to exploration sufficiently early and all cases that cannot be operated upon have a hopeless prognosis. It is a sad fact that only 16 of the 100 cases seen at the Lahey Clinic in the last six and a half years were suitable for resection and that 72 of them were too far advanced at the time diagnosis was made to justify exploration.

The cure of a patient with a carcinoma in the upper two thirds of the thoracic esophagus referred to by Churchill and Sweet^{8, 9} as the middle half of the esophagus is beset with many difficulties. A transpleural resection at this level requires the establishment of properly planned and executed gastric and esophageal communications with the anterior body wall either preliminary or contemporary to the resection so that a rubber tube or an antethoracic esophagoplasty can be used subsequently to reestablish continuity between the upper and

lower stomach. Many stages and considerations have been used in an attempt to accomplish a satisfactory physiologic end result. To justify subjecting a patient to the risk and suffering of many operations it is essential first that he have a reasonable chance of cure. To this end, every effort is made to determine operability of the lesion in advance.

Formerly we felt that the first stage should consist of laparotomy and some sort of gastrostomy for feeding the patient¹ in most instances to be used later in the construction of an artificial esophagus. We preferred the Beck Jianu type making a tube from the greater curvature of the stomach and elevating it as far as possible up the chest wall. The stoma often can be brought up to the nipple line. Since one of the earliest sites of metastasis of mid and lower esophageal carcinoma is to the subdiaphragmatic lymph nodes this furnished another reason for preliminary laparotomy as thoracotomy might thereby be avoided. If no evidence of metastasis was found the Beck Jianu gastrostomy tube was made and as much time as necessary was taken to get the patient in suitable condition for the transthoracic resection.

Lately we have realized that all except completely obstructed patients can be fed intensively on high caloric liquids with vitamin supplements and thus prepared for operation as well as by gastrostomy or jejunostomy. Secondly, since the stomach is often contracted from disuse it may be too small for making a satisfactory tube and at the same time saving enough tissue for continued effective gastric function. Thirdly, this type of procedure often temporarily increases the debility that exists in association with the malignant disease and we have seen several weeks elapse before the patient regained his equilibrium. Fourthly, even after the laparotomy one still does not know whether the carcinoma is inoperable from direct extension and laparotomy, plastic gastrostomy and thoracotomy amount to considerable surgery to establish this point. In other words surgical procedures of a combined diagnostic and therapeutic nature which because of the findings may be restricted to palliation should be kept within limits that will afford palliation rather than make the patient worse. Fifthly, we have learned to mobilize the stomach itself more and more and have observed that it functions better with a stoma only in its upper end than when divided into a tube.

In an apparently operable midesophageal lesion we now proceed by opening the left chest as the first stage and determining operability. If resection seems feasible after thoracic and abdominal exploration through the incised diaphragm the esophagus is divided from the cardia on the gastric side. Although the lower esophagus makes a better stoma than the stomach from the viewpoint of later plastic reconstruction it should be discarded because of the pronounced tendency of carcinomatous cells to migrate downward into the submucosal esophageal lymphatics. The upper end of the stomach is closed and fastened

to the abdominal wall beneath the left costal margin where a catheter placed into the stomach for feeding purposes emerges through a stab wound. The entire esophagus is then mobilized and divided above the tumor. The cervical esophagus is drawn out through a small incision in the lower left neck and its end if long enough is implanted in a stab wound below the clavicle. Closure of the diaphragm and chest wound completes this stage.

A few weeks later the abdomen is opened, the stomach mobilized and carried as far as possible up the chest wall and a stoma established. Some weeks or months later the construction of a connecting skin tube can be undertaken.

The thoracic approach to tumors of the lower third of the esophagus offers certain advantages over the abdominal route even when a large part of the lesion may lie within the cardiac end of the stomach. A wide and direct exposure is allowed. After opening the diaphragm one can mobilize any part or all of both the stomach and esophagus and sometimes the pylorus can be elevated to the diaphragmatic hiatus. The lower end of the stomach can be preserved for direct anastomosis with the esophagus or if preferable a total gastrectomy can be done prior to an esophagojejunostomy. The possibilities of wide resection and reanastomosis are the great advantages of this approach. For lesions that lie or extend more than 2 inches up the esophagus it is the only exposure which will permit such a procedure. However I wish to make clear our preference for gastrectomy by way of the abdominal route for the majority of upper gastric lesions and to emphasize that disease involving only the terminal inch of the esophagus as an extension upward of gastric malignancy can be removed through the abdomen as successfully as through the thorax. Lahey and Marshall^{13, 14} have described the technic of total gastrectomy as we employ it to mobilize the terminal esophagus and to effect anastomosis with good exposure. The morbidity is less and complications fewer if only one major body cavity must be opened. These cases of lower third trans thoracic resection then represent only those which in our opinion were inoperable by the abdominal route.

The anastomosis of the esophagus to the stomach or jejunum is like any other upper alimentary tract two layer anastomosis with these exceptions. Only fine interrupted stitches should be used in order to prevent narrowing of the esophageal lumen which would result from use of a running suture. The tumor bearing portion is left partially attached to the esophagus until the two posterior layers of the anastomosis are completed. The remaining attachment is gradually divided working from each lateral margin toward the center just ahead of the interrupted Lembert enfolding stitches placed as the first row of the anterior layer.

These two simple points have been of incalculable value in making a technically satisfactory anastomosis with reasonable ease in a region

that is admittedly difficult. As an additional safeguard against stenosis, the esophagus is cut across obliquely rather than transversely. Inversion of the esophagus into the stomach cavity is mentioned only to be condemned because later stenosis is almost certain to occur. We believe meticulous union by layer to layer suture is preferable.

Carcinoma located between the aortic arch and the inferior pulmonary vein if resectable usually has had to be followed by exteriorization procedures. We have not performed an end to end esophageal anastomosis but reported attempts after removal of malignant disease have been uniformly unsuccessful. The reasons for this are not hard to understand. The esophagus has no serosal covering and lacks mobility. Its meager blood supply has no collateral support. Its muscle fibers run longitudinally and retract strongly away from a transverse incision.

To my knowledge in the last year however at least 3 cases of carcinoma in this location have been resected with restoration of continuity by esophagogastric anastomosis at or near the aortic arch. Sweet¹⁹ has told us of a case and Garlock¹⁰ has reported a case. Our patient died of right heart failure and pulmonary edema three days afterward. Autopsy showed the anastomosis to be watertight and there was no pleural infection so we think there is merit in the method. The high upward mobilization of the stomach in each of these 3 instances depended upon division of the upper branches of the left gastric artery near the lesser curvature as well as complete mobilization of the greater curvature. We believe these cases indicate progress in a trying field.

Infection is a hazard secondary only to inoperability in carcinoma of the esophagus and scrupulous attention must be given to its prevention. The outstanding causes are soiling during the operative procedure and leakage from the suture line. Helpful preventive details include the use of cellophane incorporated protective pads, constant light suction at the suture line during placement, a Miller Abbott tube on suction with its end 1 inch above the level of division and the balloon 50 per cent inflated. It seems redundant to state that the suture line must be made and maintained completely free of tension but this fact really cannot be overstressed. Even the slightest violation of this principle usually means a fatality from leakage and mediastinitis. Sulfanilamide is routinely applied locally at completion of the resection because of its proved bacteriostatic effect and blood levels of 3 to 4 mg per cent are maintained by appropriate parenteral administration of sodium sulfadiazine from forty eight hours preoperatively until one week postoperatively.

Closed intercostal catheter drainage of the pleural cavity should be carried out for a few days until postoperative serum exudation has subsided and the danger of pulmonary atelectasis is past. Transfusions both during and immediately after the operation are also routinely

used Fluid electrolytes protein in the form of amino acids and the water soluble vitamins are supplied parenterally during the first week following operation. Administration of water is started by mouth or gastrostomy on the fourth day and the diet is increased gradually each day thereafter until a soft solid peroral or full gastrostomy intake is attained on the fourteenth postoperative day.

RESULTS

Twelve of the 28 patients submitted to surgical exploration were inoperable because of extension or metastasis or both. Six lesions were adenocarcinoma and 6 epidermoid carcinoma in type.

SUMMARY OF 100 CONFIRMED CASES OF CARCINOMA OF THE ESOPHAGUS July 1 1937 to December 31 1943

Inoperable		72
Operable		28
Exploration only		12
Epidermoid carcinoma	6	
Adenocarcinoma	6	
Resection		16
Adenocarcinoma (resection and esophagogastrostomy)	10	
Lower third	9	
Middle third	1	
Hospital deaths	4	
Hospital survivors	6	
Now surviving (25 months)	1	
Later deaths (3 6 10 13 and 50 months)	5	
Epidermoid carcinoma		6
Lower third (resection and anastomosis)	1	
Now surviving (16 months)	1	
Middle third (Torek operation)	5	
Hospital deaths	3	
Hospital survivors	2	
Now surviving (12 months)	1	
Later deaths (3 months)	1	

Sixteen patients had a resection performed. There were 7 hospital deaths (4 patients with adenocarcinoma and 3 with epidermoid carcinoma) and there were 9 survivors. Six of these 9 patients lived for periods varying from three to fifty months after leaving the hospital.⁷ Five patients had adenocarcinomas and 1 had epidermoid carcinoma. They eventually died from recurrence or remote metastasis. Three patients (1 with adenocarcinoma and 2 with epidermoid carcinoma) have survived for twelve months sixteen months and twenty five months respectively.

In respect to classification location and type of resection the results were as follows. Nine of the 10 adenocarcinomas were located in the

lower third of the esophagus and the tenth had extended upward to involve the middle third. Resection in each case was followed by esophagogastrostomy. In the tenth case the anastomosis was made just under the aortic arch. Four patients died in the hospital. In the 6 patients who survived hospitalization death occurred later at the six, ten, thirteen and fifty months. 1 patient is still living at twenty five months.

Five of the 6 epidermoid carcinomas were located in the middle third of the esophagus and 1 was located in the lower third. Resection of the lower third lesion was followed by esophagogastrostomy and the patient is living sixteen months after operation. A Torek's operation was done in the other 5 cases. Three patients died in the hospital and 2 survived. One of these survivors died three and a half months later of aspiration lung abscess and at autopsy a small metastatic nodule was also found in the mediastinum. The fifth patient is living one year after operation and uses a rubber tube connection between the esophageal and gastric stomas for feeding purposes.

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THE DEVELOPMENT AND IMPROVEMENT IN THE SURGICAL TREATMENT OF BRAIN TUMORS DURING THE LAST THIRTY FIVE YEARS

GILBERT HORRAX

SOMEWHAT more than three decades have elapsed since the radical attack on tumors of the brain was begun by Sir Victor Horsley in England and by Dr Harvey Cushing in this country. Many and significant advances along various lines have taken place since those early days but it is still most difficult to displace from the minds of the medical profession the notion—which became firmly fixed in the pioneer days of neurosurgery—that all brain tumors are pretty hopeless lesions that even though some might be removed successfully the vast majority recur and in the meantime the patients are at best semi-invalids. There was much to warrant such a point of view for a long period of time and indeed from the days of the earliest attempts at brain tumor surgery (1880–1890) until at least the end of the first decade of the twentieth century (some thirty years) the statistics of useful survival after brain tumor operations were so devoid of encouragement as to make it seem that such operations were indeed hardly worth while.

EARLY ATTEMPTS AT TUMOR EXTIRPATION

Aside from an occasional brilliant result after the removal of an encapsulated intracranial growth (Macewen 1879¹⁴ Durante 1884⁹ and Keen 1887)¹¹ the vast majority of these early attempts at tumor extirpation either ended disastrously or with only temporary relief from the symptoms. Indeed not only were most of the growths incompletely removed but in addition an extremely small percentage of tumors were considered capable of removal by the neurologist who in those days had great difficulty in persuading a surgeon to undertake the operation.

As late as 1906 Knapp¹ a leading neurologist in Boston and one who had been particularly interested in urging operations for brain tumors collected 828 cases from the literature in which attempts at tumor extirpation had been made. It was said that 471 of the tumors had been removed but complete removal as we now know it was certainly the exception rather than the rule and therefore recurrence and eventual death was the final outcome in a large proportion of these cases. In 357 instances the growth was not removed and there were 265 deaths following operation. Furthermore Knapp found from his study of such follow up records as were available that most of the patients who were said to have recovered only lingered on for a time paralytic epileptic or blind.

Results such as these would, of course, mar the idea of hopelessness concerning the efficacy of brain tumor surgery in the mind of all physicians and from them, in the mind of the public. I became generally agreed by all the leading neurologists of the time and by most of the surgeons who had dealt with these lesions in 1901 to 10 per cent of all brain tumors were capable of being operated upon with the prospect of a successful result. It is to be noted, however, that Horsley and Cushing, the great pioneer neurosurgeons, were subscribed to this idea and it was they who began and continued a attack upon brain tumors to the point where it could be said that patients harboring such a growth would have at least an even chance of having it removed, and if removed, an excellent chance of surviving for a period ranging from five to thirty years.

PROGRESS SINCE 1910: A REVIEW OF CUSHING'S AND DAY'S

To gain a clearer and more detailed idea as to how the improvement was accomplished, the years since about 1910 may be divided into three approximately equal periods of ten to twelve years each. At the beginning of the first of these periods, the progress of brain tumor surgery has been noted. In addition to the statistics given, another highly important and oft-quoted paper is that by Toon in 1913. This was an analysis of the brain tumor patients operated upon himself by Horsley at the National Hospital, Queen Square, London. Of the 76 patients operated upon, 187 had tumors which were verified histologically. According to Cairns¹ who reviewed Toon's series in 1936 in order to determine end results so far as possible, at least 87 postoperative deaths occurred. This was an operative mortality of 46 per cent. Of the survivors, 31 (16.4 per cent) lived from nine months to nine and a half years. Of these, 14 (7.4 per cent) were probably useful citizens.

In 1914 Künimüller reported the results from his Clinic in Breslau. There were 64 verified tumors in 104 patients operated upon, and his operative mortality was 33 per cent. There were 24 patients (23 per cent) who survived the operation for periods up to six years, and of these, 11 (17 per cent) were considered cured for from six months to six years. Künimüller stated that Krause's mortality (Berlin) was about 50 per cent and that von Eschberg's (Vienna) was 55 per cent.

Shortly before the publication of these two papers, a considerably more hopeful note had been sounded in the United States in regard to brain tumors. In 1910 Cushing² reported his results with 64 patients stating that "16 cases after removal and 21 cases after decompression are to be conservative, greatly benefited and a number of them probably cured, making a percentage of 78 out of the 64 patients still here retained, temporarily at least, a full measure of health." Furthermore, Cushing's mortality in this group was 12.5 per cent, contrasted with 35 to 50 per cent in the European clinics. Likewise in discussing

Kuttner's paper in 1915 Cushing³ again reported the then almost unbelievable low mortality of 8.4 per cent for operations upon 130 brain tumors. Although end results were not discussed these mortality figures at least showed that patients with brain tumors could be operated upon with comparative safety and that the prevailing prohibitive mortality rate was capable of being greatly improved.

Further progress with a specific type of brain tumor namely the acoustic neuroma or cerebellopontile angle tumor was also furnished by Cushing⁴ in his monograph in 1917. By the intracapsular extirpation of these benign but inaccessible growths the previous excessive mortality of 70 to 80 per cent was reduced to 20 per cent or less, and a large proportion of patients were returned to useful life for periods of five to ten or more years.

From what has been said it is evident that considerable progress had been made in brain tumor surgery particularly by Cushing in the five year period from 1910 to 1915. Even if the actual cures up to this time were still in the minority at least it was shown that these serious intracranial operations could be conducted with a much lower mortality than had ever been known previously and many patients were being benefited by the operative procedures.

During the next twelve years several significant advances in the treatment of brain tumors occurred. In 1918 Dandy⁵ advocated the injection of air into the cerebral ventricles as an aid to the diagnosis and localization of brain tumors by subsequent roentgenologic study. This has proved to be of the utmost value since it not only has enabled the neurosurgeon to be certain of the presence of at least one third more brain tumors than was possible by purely neurologic methods but also has enabled us to gain a much more accurate idea of the localization of the tumor and thus to attack it more intelligently and safely. Another great aid in the surgical attack upon brain tumors during the decade between 1920 and 1930 was the study of the individual tumor groups by Cushing and his pupils. By finding out what particular tumors were most likely to be present in a specific area and by learning the signs and symptoms to which they gave rise the neurosurgeon again was able to operate with greater assurance and greater foresight and thus to accomplish more than when the lesion was encountered unexpectedly and without proper preparation for measures which might be necessary. In addition to these two diagnostic advances two highly important technical aids to brain surgery were developed between 1920 and 1930 namely the use of strong suction and the electrosurgical cutting and coagulation apparatus.

Because of the diagnostic and technical aid just cited the complete removal of brain tumors with permanent recovery of the patient became increasingly possible. The complete extirpation of cerebellopontile angle growths (acoustic tumors) was advocated by Dandy⁶ in 1922 and has become practically routine in most neurosurgical clinics.

—and this with a mortality as low or lower (8 to 10 per cent) than was possible with the older method of intracapsular extirpation. During 1920 to 1930 pituitary tumors were removed with greater completeness as operators gradually adopted the intracranial approach instead of the transphenoidal operation with its very limited exposure. It was also learned that roentgen ray treatments might cure a certain number of pituitary adenomas but that the best combination for a permanent cure was operative removal followed by roentgen ray treatment.

Perhaps the best general figures as to what was being accomplished for brain tumors during this decade are those prepared by Davidoff in an analysis of Cushing's patients during the three year period 1924 to 1927 after an interval of seven to fourteen years. Of 457 patients with all types of tumor both benign and malignant 170 (37 per cent) were living from seven to fourteen years after operation. As nearly as can be determined from the statistics given* there were in all probability almost 100 who led useful lives.

Thus if this series is compared with that published by Tooth¹ in 1913 a great advance in the treatment of brain tumors in the twenty odd year interval is noted.

TOOTH'S SERIES OF 187 TUMORS 1913 (Operations largely by Victor Horsley)	DAVIDOFF'S SERIES OF 457 TUMORS 1940 (Operations by Harvey Cushing 1924 to 1927)
Survivors (9 months to 95 years)= 31 (165 per cent)	Survivors (7 to 14 years)= 170 (37 per cent)
Useful survival = 14 (74 per cent)	Useful survival = 97 (21 per cent)

What can be said as to improvement in brain tumor surgery during the last decade? In the first place technical methods have improved as neurosurgeons have gained experience particularly in the combined use of suction and electrosurgical coagulation as well as in various other small details all of which have an accumulative value. Newer methods of anesthesia have been helpful with an increasing number of highly trained anesthetists in all hospitals and clinics. The more frequent use of transfusions and thus the near elimination of operative shock has played an important role as have the recognition and treatment of postoperative atelectasis.

PRESENT DAY RESULTS

The statistics for present day operations on brain tumors particularly as to useful survival are confined largely to reports on specific types of tumor and this is perhaps the best way in which to gain an

Davidoff gives figures for useful survival in all groups except the pituitary adenomas. There were 59 patients with this type of growth and I have estimated that roughly one half (30) of those were in useful life.

accurate idea as to the accomplishments when intracranial growths are of such great variety. Thus it is known that the benign tumors such as meningiomas, acoustic neuromas, pituitary adenomas, cerebellar astrocytomas, hemangiomas, and a considerable number of miscellaneous tumors in most instances can be completely removed with a mortality of approximately 10 per cent or less. The vast majority of these patients should never have a recurrence and should live useful lives thereafter.

According to the statistics on a series of 400 patients with brain tumors operated upon at the Lahey Clinic between 1932 and 1939,¹ 56 per cent of all the growths came within what was termed a favorable category, that is, tumors which could have or should have been removed and the patients cured. Actually, in the follow-up period from one to eight years after operation, 187 patients survived out of the 224 classified as favorable for operation. In this favorable group the operative mortality was 12.5 per cent. One hundred and sixty of the 187 survivors were leading useful lives. Thus of the 400 tumor cases, 187 patients (46.7 per cent) survived from one to eight years, and 160 patients (40 per cent) were useful citizens. These figures do not take into consideration a further percentage of patients in the so-called unfavorable group, many of whom not only recovered from the operation but actually lived usefully for many months or even years.

A further and most hopeful aspect of the operability and survival of patients with brain tumors is furnished by Denker² who in 1939 reported upon the insurability of patients from whom brain tumors had been removed. The company which Denker represented had insured 37 such patients after careful review of their histories and the pathology of the tumor. Only 8 of the patients had died since the issuance of their policies, and only 4 of the deaths were in any way related to the tumor.

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INTRACRANIAL ANEURYSM DIAGNOSIS AND TREATMENT OF ANEURYSM OF THE INTERNAL CAROTID ARTERY

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INTRODUCTION

Intracranial aneurysms are relatively common and if they are recognized early are certainly not as hopeless as has been supposed. The etiologic factors involved in the production of intracranial aneurysms as well as their pathologic nature clearly indicate that the only logical therapeutic approach to the problem is early surgical intervention. Fortunately many cases of intracranial aneurysm lend themselves well to such treatment. Likewise the outlook becomes more pessimistic in the untreated cases because of the irreversibility of the pathologic process and the imminent dangers of rupture. For that reason early diagnosis and treatment are essential.

ETIOLOGY AND PATHOLOGY

Most investigators agree that the majority of aneurysms are of congenital origin but that arteriosclerosis, infection and syphilis have been precipitating causes in many cases.² Forbus³ and more recently Bremer¹ have offered convincing evidence in favor of the hypothesis that it is the inherent weakness of the vessel wall at the bifurcation points which predisposes it to local dilatation. There is considerable variation in the thickness of the aneurysmal wall undoubtedly influencing the size of the aneurysm and the potentialities of rupture. It may be saccular or fusiform varying greatly as to size producing symptoms either by direct pressure on contiguous structures by actual rupture or by softening of the area distal to the aneurysm as a result of ischemia.

Aneurysms occur in both sexes but are perhaps more frequent in women. Peculiarly enough they do occur more often on the left side as reported by other investigators and in our own series. This of course increases the hazard of treatment because of the possibilities of interference with the speech areas but need not necessarily prevent active surgical intervention. That many are insidious or do not form until later in life is evidenced by the fact that the majority do not manifest themselves until the later decades although they have been known to occur in children and young people. Subarachnoid hemorrhages or actual clinical manifestations are by far more common between the ages of 40 and 60.

SYMPTOMS

The usual cardinal signs and symptoms are periodic headaches usually on the side of the lesion pain in or about the eye trigeminal neuralgia in one or all the branches most commonly in the first unilateral impaired vision optic atrophy defects in the field of vision and those due to subarachnoid bleeding such as stiff neck dizziness fainting coma or convulsions The duration of the symptoms may vary from days to years before recognition of their importance Headache is by far the most frequent initial symptom and many patients have been treated for migraine for years before the seriousness of the pathologic change revealed itself by the addition of ocular motor palsy or signs of rupture Although the syndrome is usually of sudden onset it may be insidious particularly when there is no pain Either impaired vision or extra ocular muscle weakness may represent the initial symptom

Among the less common findings are papilledema retinal hemorrhages exophthalmos bruit symptoms of pituitary dysfunction and internal hydrocephalus The objective presence of the bruit is exceedingly rare although subjectively it is relatively more common At times one finds cases simulating pituitary adenoma sphenoid wing meningioma craniopharyngioma tumor of the corpus callosum malignancy of the nasopharynx trigeminal neuralgia atypical facial neuralgia sinusitis and meningitis

DIAGNOSIS

Although the clinical syndrome referred to previously is almost pathognomonic of aneurysm of the internal carotid artery or anterior portion of the circle of Willis it is only presumptive Verification rests upon the findings of roentgenologic examination pneumoencephalography and arteriography or exploration

Roentgenogram—Accurate roentgenologic interpretation of films is dependent upon the quality of the film as well as the experience of the roentgenologist In order to visualize small lesions in or about the sella turcica properly exposed well developed stereoscopic films of the cranial vault in the exact lateral position are necessary One must be able to visualize both the anterior and posterior clinoids from a lateral view and the tips of these processes from anteroposterior and posteroanterior projections Calcified aneurysms may be visualized directly On the other hand if calcification is absent then erosion sharpening or elevation of the clinoid processes is significant Often one sees a unilateral erosion of the lateral wall and floor of the sella turcica enlargement of an optic foramen particularly when the aneurysm is in a cavernous sinus or thinning and erosion of the sphenoidal ridge Secondary changes in the sella turcica or dorsum sellae may result from internal hydrocephalus caused by blocking of the subarachnoid spaces with blood following rupture and subsequent in

interference with the cerebrospinal fluid circulation or from direct blockage of ventricular drainage by the aneurysm if of sufficient size.

Ventriculogram and Encephalogram—In small lesions these studies usually are normal however they may attain such size as to distort or produce filling defects in the anterior and temporal horns of the lateral ventricle the third ventricle and the basal subarachnoid spaces (pontis interpeduncularis and chiasmal). As mentioned previously internal hydrocephalus frequently is demonstrated.

Arteriogram—This method of diagnosis is unquestionably the most accurate. Treatment can be carried out as soon as the diagnosis is established without subjecting the patient to another operative procedure. Exposure of the carotid arteries is carried out under sterile conditions. Satisfactory films may be obtained by the direct injection of 4 to 8 cc. of thorarist into the internal carotid artery. This should be so timed that exposure is simultaneous with the injection of the last 2 cc. of fluid. Single or stereoscopic lateral films are taken with the patient in the supine position. Tolerance for complete occlusion of the internal carotid artery can be determined while waiting for development of the roentgenograms. If the pictures are suitable aneurysmal dilatation if present readily can be identified.

TREATMENT

Conservative measures as a rule are disappointing. It is true that if a patient has had one episode of hemorrhage with recovery he may go on for many years with no treatment other than the avoidance of all unnecessary procedures that have a tendency to increase intra-arterial tension.

Surgical interference should be instituted in patients who have had more than one hemorrhage regardless of their present symptoms since the probability of a fatal hemorrhage is great.

Surgical treatment of an aneurysm is either direct by exposure of the lesion through a craniotomy or indirect by ligation of the common or internal carotid artery. The procedure chosen depends upon the individual case. Craniotomy which is hazardous should be undertaken only when the site of the aneurysm is favorable for excision, trapping or reinforcement of the weakened wall. Indirect surgical treatment is less hazardous and easier to accomplish.

Before one attempts to ligate any of the great vessels of the neck he must be certain that the collateral circulation to the brain is adequate. This is best tested by preoperative fractional compression of the artery to be ligated until the patient is able to withstand complete closure for ten minutes three times a day. Only those patients who have classical symptoms and signs and who we definitely feel have an aneurysm are subjected to this procedure.

Patients with actual bleeding are treated conservatively until the

bleeding stops. However during this interval they are prepared for surgery. It is important to determine whether the patient has an irritable carotid sinus and if so compression of the common carotid artery proximal to the carotid bulb should be carried out. Before applying the Light collar the initial digital compression of the artery is performed for one half to one minute. If there are no signs of inadequacy of circulation or irritable sinus the collar is applied each day until the patient is able to tolerate closure for ten minutes.

When the preparations are complete the artery is exposed under local anesthesia. This serves two purposes namely it anesthetizes the carotid sinus with novocain and thus prevents any sequelae from irritability and it determines whether the patient is able to tolerate complete occlusion. A complete or partial occlusion of the common or internal carotid artery then is performed. After ligation and closure of the wound the patient must be placed in the Trendelenburg position for three days to insure adequate circulation of the brain. The maintenance of normal blood pressure is important in order to prevent circulatory changes that may be disastrous.⁵

REPORT OF CASES

CASE I—A 37 year-old woman was admitted to the hospital on September 29 1943 with a complaint of left sided frontal headache nausea and vomiting for six weeks and paralysis of the left eyelid for three days.

Six weeks previous to admission she suddenly developed a severe throbbing left frontal headache that provoked nausea perspiration and vomiting. She rested and recovered in twenty four hours. One week later she had a similar attack and a diagnosis of migraine was made.

One week previous to admission she fainted became rigid and was unconscious for six minutes. There were no focal convulsive movements.

Three days previously the left eyelid began to droop and completely closed within forty-eight hours. There was no history of head injury no previous visual disturbances or any other neurologic symptoms. The personal and family histories were noncontributory.

On admission the blood pressure was 83 mm of mercury systolic and 50 mm diastolic. The pulse rate was 80 and the respirations 16. The heart and lungs were normal.

Urinalysis was essentially negative. The hemoglobin was 14.1 gm erythrocytes 4 160 000 and leukocytes 7 850. Differential count showed polymorphonuclear cells 72 lymphocytes 26 and eosinophils 2 per cent. The blood Hinton test was negative. The initial pressure on lumbar puncture was 300 mm of water. The fluid was grossly bloody. Chemical examination showed 2 700 red blood cells. Stereoscopic lateral skull plates were negative.

On neurologic examination the neck was moderately stiff. There was no evidence of bruit on auscultation over the eye and entire skull. There was a complete left ophthalmoplegia involving the third fourth and sixth nerves. The disks were normal in outline. There was no evidence of any optic atrophy papilledema or retinal hemorrhages. The remainder of the cranial nerves were normal. All

deep reflexes were equal and active. There was no Babinski or Hoffmann's sign. There was no evidence of weakness, paralysis or atrophy in the extremities. No disparity to the testing of position, vibration, pinprick and to touch.

The diagnosis was aneurysm of the left internal carotid artery with recent rupture and the patient was placed on fractional occlusion of the carotid artery in preparation for arteriograms and ligations. Arteriograms which were made on October 7 demonstrated a large aneurysm of the internal carotid artery (Fig. 265). The common carotid artery was completely ligated and the external carotid artery was partially ligated.



Fig. 265—Aneurysm and dilatation of left posterior communicating artery.

The patient made an uneventful recovery, suffering no sequelae. However, she still had complete left ophthalmoplegia. She was discharged in three weeks, improved. The headaches had greatly improved and the stiffness had disappeared.

Comment—This case showed the classical history and findings of an aneurysm of the internal carotid artery, in that the symptoms began acutely with unilateral headache which was present for five weeks before the onset of convulsions and left ophthalmoplegia indicated the presence of rupture. A diagnosis of migraine had been made previously. Subarachnoid hemorrhage is almost invariably found if the patient is seen early.

CASE II—A 55-year-old woman with first seizure the first of May, 1944, with a complaint of double vision. She was apparently well until five years before.

fore admission when she suddenly developed double vision and loss of right lateral gaze in the right eye. Soon after this she began to feel pins and needles in the right side of the face mainly in the area of the first and second divisions of the trigeminal nerve. This sensation disappeared after a year however a feeling of numbness in the right side of the face had remained. There was no history of localized headaches, tinnitus, deafness, trauma or hypertension.

Roentgenologic examination showed an atrophic sella turcica and partial destruction of the right anterior clinoid process which was pushed upward. The roentgenologic interpretation was aneurysm in the right internal carotid artery.

The patient was first seen in the Department of Neurosurgery on June 7 and gave essentially the same history as previously described. There was a partial



Fig. 66—Large aneurysm of right internal carotid artery just lateral to sella turcica showing clot in central portion.

right ophthalmoplegia, absent right corneal reflex, anesthesia of the right first division of the trigeminal nerve and analgesia of the right second division of the trigeminal nerve. The fundi were normal. The remainder of the cranial nerves and the motor and sensory reactions were normal. All deep reflexes were active and equal. There was no Babinski or Hoffmann's sign.

She was admitted to the hospital on July 8 and immediately was placed on fractional compression of the common carotid artery. On July 14 the right internal carotid artery was exposed and injected with thorotrast. Roentgenograms of the skull showed a smooth walled aneurysm of the right internal carotid artery about 3.5 cm in diameter just lateral to the sella turcica (Fig. 266). The aneurysm showed a clot within its central portion. The right common carotid artery was completely ligated. The patient made an uneventful recovery, suffering no sequelae from the treatment and was discharged on July 24.

Comment—The symptoms of this patient were of long duration which is not uncommon when the initial complaint is impaired vision. In addition the lesion was apparently large enough and so located as to involve the first and second divisions of the trigeminal nerve. Oddly enough the fundi were normal in spite of the presence of such a large lesion. Partial thrombosis of the aneurysm is well shown on the arteriogram.

CASE III—A 44 year old man was first admitted to the hospital on January 19, 1944. He had had two subarachnoid hemorrhages within the last two and a half years. Before this he was apparently well. His difficulty began with severe head



Fig. 6—Aneurysm at bifurcation of internal carotid artery and posterior cerebral artery. Extracranial portion also shows slight dilatation of internal carotid artery just below base of skull.

ache at the back of the neck and radiated forward over the brow. Associated with this was tingling and loss of sensation in the scalp. He was hospitalized and a lumbar puncture was performed which grossly showed bloody fluid. He recovered in two weeks but since that time had periodic severe headaches, mostly on the left side. The pain often radiated. On December 7, 1943, he was again suddenly stricken and headache became restless stuporous and confused. He was found to have a subarachnoid hemorrhage. Physical examinations and laboratory and roentgenologic studies were reported as normal. The personal and family history was negative except for a vague history of epilepsy previously.

The patient did not appear chronically or acutely ill. The heart and lungs were normal. The blood pressure was 100 mm. of mercury systolic and 70 mm. diastolic. The respirations were 16. The fundi were within normal limits. There was no evidence of optic atrophy, papilledema or retinal hemorrhage. The pupils were equal and reacted to light and accommodation. The extra-ocular movements were all intact. Examination of the remainder of the cranial nerves was normal. All deep reflexes were active and equal. There was no Babinski or Hoffmann sign, weakness, atrophy or fibrillation. There was no disparity to the sense with pinprick, touch, vibration or position.

Laboratory studies were omitted because they recently had been performed at another institution. In so far as they were all normal except for the lumbar puncture, their repetition seemed unnecessary.

The patient was placed on fractional carotid artery compression and after five days the left carotid artery was exposed and incised with the otic. Roentgenograms showed a moderate-sized aneurysm (Fig. 6). The left common carotid and left external carotid were completely ligated, and the left internal carotid was partially ligated. The patient had an uneventful recovery and improved substantially.

Comments.—This patient's illness revealed itself by the symptom complex of severe unilateral headache and subarachnoid hemorrhage. Both the physical and neurologic examinations were essentially negative. Aneurysm should always be looked for in the presence of unexplained subarachnoid hemorrhage, particularly in the absence of hypertension.

CASE IV.—A 47-year-old woman was admitted to the hospital on January 1, 1934, complaining of intermittent diplopia for several years, severe headache for six months, and nausea and vomiting for two days.

She was apparently well until seven years previous, when ten days after a head injury she developed strabismus which lasted eight months. She was in a hospital for several weeks. Roentgenograms of the skull and lumbar puncture were negative. Two years later she again sustained a mild head injury which also was followed by interval strabismus for two months. Roentgenograms and lumbar puncture again were negative. Since her cerebral accident she had had transient diplopia, often associated with nausea. For the last two years the vision in the left eye had been impaired.

Six months previous to her present admission the patient began having severe frontal-parietal headaches often lasting several days. These headaches were paroxysmal and often associated with nausea and vomiting. Her most recent attack was two days before admission. There was no history of trauma, suffocation or consciousness although she claimed to have poor memory since the cerebral attack seven years previous. The personal and family histories were unremarkable.

The blood pressure was 100 mm. of mercury systolic and 60 mm. diastolic. The pulse rate was 80 and the respirations, heart and lungs were normal. Neurologic examination revealed some mental sluggishness and absent abdominal reflexes. The fundi were well within normal limits. Electroencephalogram, on January 10, showed an abnormal record with paroxysmal slow activity in

frontal cortex. Roentgenograms of the skull revealed atrophy of the sella turcica and erosion of the right anterior clinoid process, which are typical changes seen with aneurysm of the intracranial portion of the internal carotid artery.

On January 6 arteriograms were made after thorotrast had been injected into the right internal carotid artery. These showed a large aneurysm in the intracranial portion of the artery at the site of erosion of the right anterior clinoid process (Fig. 268). The right common internal and external carotid arteries were partially ligated. Except for marked drowsiness she made an uneventful recovery and was discharged on February 4. She was somewhat improved but was not completely relieved of the headache.



Fig. 268—Intracranial aneurysm of right internal carotid artery.

The patient was readmitted in March because of a recurrence of severe headaches and the physical examination was essentially the same as on previous admission. On March 10 the common carotid artery was ligated and divided just below the bulb of the internal jugular vein. The patient was relieved of the severe headache. She made an uneventful recovery and was discharged eleven days later, much improved.

CONCLUSIONS

The history and clinical findings in most cases are diagnostic of aneurysm but due to the fact that intracranial tumors and other diseases present similar syndromes we believe that diagnosis should be confirmed by arteriography. Our series of 30 cases treated surgically indicates that this is the only method of treatment by which one can expect hopeful results.

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MANAGEMENT OF THE URETHRAL CATHETER

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POSTOPERATIVE use of the urethral catheter is frequently a necessary evil and upon skill and judgment in its management may hinge the successful outcome. This is especially true in the aged in whom the additional burden of urosepsis caused by a poor catheter regimen may well represent the difference between surgical defeat and victory.

INDWELLING CATHETER

Indications—The indwelling catheter perhaps finds its greatest usefulness in the postoperative management of patients who have had gynecologic, rectal and transurethral surgery. In the former two groups a temporary neurogenic hypotonic bladder following reflex spasm of the sphincter may be present. In transurethral surgery a successful outcome depends almost entirely upon minute and painstaking care of the urethra to allow for unimpeded drainage.

Size—The size of the catheter is important. Care in the selection of the correct caliber is just as essential as the indications for its use.

The catheter must be large enough for adequate drainage and yet not so large as to overdistend the urethra and meatus with the development of periurethritis and subsequent stricture. A catheter larger than the external urinary meatus prevents proper drainage of urethral secretions and may cause a rather profound urethritis with symptoms for many months. It must be remembered that the external urinary meatus is usually the narrowest portion of the urethra. If too large a catheter is inserted and the external urinary meatus is forcibly dilated and constricted tightly about the catheter the patient will complain bitterly and many subjective symptoms will ensue to mar an otherwise smooth convalescence. In selecting a catheter this should be kept in mind. As a rule for postoperative drainage a size larger than 20 F is not needed and frequently a size 18 or 16 F will answer the purpose. Large stiff rubber catheters must be avoided.

A self-retaining catheter such as the Foley bag type is satisfactory for routine use. It is self-adjusting as to the depth of catheter projection into the bladder and eliminates the use of adhesive tape. It easily can be attached to a closed drainage system and irrigated semi-automatically with boric acid or other suitable solutions. The bag that is distended to 30 cc is more useful than the smaller 5 cc size especially in females who frequently complain of trigonal symptoms ranging from slight irritation to almost constant bladder tenesmus when the smaller bag is used. Patients have even been known to pull out or pass spontaneously a 5 cc Foley bag catheter while straining

It also prevents the catheter from becoming engaged in the posterior urethra of males

Position—Upon the position of the fenestra of the catheter of course depends the drainage. The catheter which is inserted too deeply into the bladder will curl upon itself and cause undue bladder irritability and at the same time will not provide complete drainage. On the other hand a catheter which is not in far enough will also drain poorly and cause overdistention. All these factors may lead to the development of prostatitis and epididymitis in the male with a greatly troubled postoperative course from bladder spasm, overdistention and upper urinary tract damage of varying degrees. A simple procedure when using the straight catheter is first to push the catheter well into the bladder, gradually withdrawing it until drainage stops. The catheter is then inserted for a distance of 1 inch and fastened in place.

Many methods for fastening the catheter into position have been devised, all successful or unsuccessful depending upon the amount of care used. Paraphimosis may be the result of tying a catheter to the penis with the prepuce retracted or the lack of daily inspection of the catheter to avoid overlooking change in position. No amount of fastening with adhesive tape, silk ties or any other device will dispense with daily inspection of the bindings. The adhesive strips must be cleansed and changed frequently, and the natural inclination to avoid this job is perhaps directly responsible for a good many ensuing complications.

Complications—In any patient with unexplained fever who is on indwelling catheter drainage, peri urethritis, peri urethral abscess, prostatitis and epididymitis must be kept in mind. A daily ritual of running the hand along the urethra and in the perineum should be adopted to forestall the development of peri urethritis or abscess formation. Any undue soreness or induration should be scrutinized carefully, and if found the question of removal should be considered. Investigation of the cause of fever in the postoperative patient demands careful elimination of the external genitalia and prostatitis by rectal examination. The urethra is very vascular and absorption from it is great. Fatal sepsis has resulted many times from infections in this locality. If urethritis, peri urethritis or prostatitis is producing fever, it may be necessary to resort to suprapubic drainage either by trocar puncture or cystostomy.

The frequency of many of these complications has been diminished considerably by the prophylactic use of small doses of sulfathiazole or sulfadiazine in patients continued on indwelling catheter drainage. Postoperative follow up of male patients who have been on catheter drainage for a long period is frequently necessary, and meatal narrowing and prostatitis are cared for. A chronic low grade nonspecific prostatitis which has been brought to the fore by catheter drainage

or developed by long employment of a catheter can be exceedingly resistant to treatment long after disappearance of the original surgical condition for which the patient entered the hospital. Women especially in the older age group may be left with a marked urethritis. It may be necessary for them to have warm douches or hot sitz baths and dilatation of the urethra with the instillation of medication.

Management—The catheter should be attached to a closed drainage system consisting of a sterile irrigating bottle 2 or 3 feet above the level of the bed and a sterile white collecting bottle on the floor. These two bottles are connected by sterile rubber tubing to a Y tube which should be inserted directly into the catheter thus reducing to a minimum the amount of urine in the system which must be returned to the bladder with each irrigation. We have found this system the easiest to handle routinely on the various hospital services with the rapidly changing nursing personnel. Complicated automatic irrigating devices with special traps are not always dependable. Only one clamp which is between the irrigating bottle and the catheter is employed. Any other arrangement in our opinion results in trouble. All tubing should allow for movement of the patient to prevent kinking and unnecessary pulling on the catheter. Plain saline or 2 per cent boric solution seems to work best routinely. If sulfanilamide solutions are used the tendency to crystallization in the bladder and around the catheter must be guarded against.

Intolerance to the catheter if the size and position are correct, may be combated by the use of sedation, local heat and the instillations of weak solutions of nupercaine or metacaine. Under this care few patients have an intolerance to the catheter.

Insertion of Catheter—In the male the instillation of a local anesthetic such as 5 per cent aqueous metacaine in the urethra before catheterization is of advantage. In addition if the patient is apprehensive or if some difficulty is anticipated morphine may be injected subcutaneously 15 to 20 minutes in advance of manipulation. Intravenous pentothal has been used with excellent results in the more difficult cases.

It is a sound precaution to forestall possible difficulty by having a selection of catheters ready before instrumentation is begun. The greatest single factor in successful passage of any catheter is extreme gentleness. Under some form of premedication with local anesthetic the slow careful passing of a soft straight two eye catheter will work in nearly all cases. Needless to say catheterization is carried out under sterile conditions with the operator wearing gloves.

Trauma to the congested prostate gland with all the sequelae which can follow may occur even when great care is exercised and when the primary requirement with regard to the flexibility of the catheter is absent. A coude or bicoude catheter should always be at hand when a patient with prostatism is catheterized. The coude catheter may be

fitted with a stilet which is curved to the particular deformity presented by the distorted urethral lumen incident to the prostatic hyperplasia. This can be roughly estimated by urethral palpation in the perineal area while a finger is in the rectum. When the tip is felt to enter the membranous urethra the outer end should be gently depressed as in passing a metal sound, when as a rule the tip will find its way along even the altered contour of the prostatic urethra into the bladder. Pressure in the face of resistance almost invariably results in perforation of the prostate by the tip of the instrument.

If attempts at passage of these catheters are unsuccessful the filiform bougie should be tried. Since the filiform tip easily can become caught in a mucosal fold, it may be necessary to use three or even four such bougies alternately passing successive instruments further into the urethra. Once passed the filiform can be attached to a stilet with an overlying soft rubber catheter lubricated on the inside as well as the

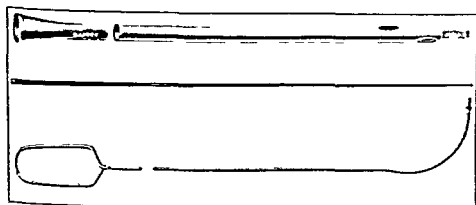


FIG. 69—Bardex Council catheter (C. R. Bard Inc., New York City.)

outside. Once the catheter has been passed, the stilet with the attached filiform is removed. The Bardex Council catheter is an example of such a trick instrument (Fig. 269). The soft rubber catheter can be taped in place if so desired. When great difficulty has been experienced in finding a way into the stricture with a filiform it may be impossible to pass larger bougies or the Council catheter. Under these circumstances, it is wise to tie the instrument in place and send the patient to bed. The urine either will dribble along the bougie or can be forced past by the patient. Twenty-four hours later as a rule a larger size can be passed, and a change is made to a catheter as soon as possible.

If a stricture is present and the surgeon finally has resorted to filiforms, success is more likely to occur when the instrument is rolled lightly between the thumb and forefinger. The rotation of the filiform results in a thorough searching of the whole stricture face where the opening often is in an eccentric position. Another helpful maneuver

is to have an assistant place a finger in the rectum and with graduated pressure press anteriorly at the prostatic apex.

Removal of Catheter—Following removal of an indwelling catheter the residual urine should be checked. Also a specimen of urine should be obtained before the patient leaves the hospital as a basis for possibly continuing oral medication at home.

CONCLUSIONS

Because the danger of urosepsis is so great with imperfect catheter management the employment of a urethral catheter postoperatively must be regarded as a necessary evil. Those responsible for the use of a urethral catheter therefore should have more than a passing interest in its proper use and management.

INGUINAL PAIN AN EARLY MANIFESTATION OF BLADDER NECK OBSTRUCTION

CARROLL D. GOODHOPE

With increasing life expectancy a greater proportion of the general surgeon's practice is in the older age group. The fact that prostatism is present in 55 per cent of men over 50 years of age¹ makes it necessary to consider and evaluate this condition in all patients over this age when surgery is contemplated.

A patient in the later decades of life who is not engaged in some strenuous form of work or exercise and who develops inguinal pain or hernia might well deserve special study before surgery is undertaken. It is reasonable to assume that he should have developed hernial symptoms during the more active years of life. In these patients it is wise to consider the possibility of prostatism as an etiologic factor. Since increased intra-abdominal pressure is produced as many as ten to twenty times daily with resultant pressure on the inguinal rings while the patient is in the act of straining to void it is easy to understand how symptoms of hernia may result.

A patient with prostatism frequently minimizes his complaints either intentionally or unintentionally. Intentionally he minimizes his complaints because of fear of prostatic surgery and unintentionally because he may not appreciate the significance of the symptoms due to their insidious onset and the mistaken idea sometimes attributed to some medical advice that increased frequency is a normal accompaniment of age.

A study of the Clinic records of 100 consecutive male patients over 50 years of age revealed that 9 per cent had a preliminary complaint of inguinal pain or hernia. When this is compared with a similar series of 100 consecutive patients with prostatism in whom 41 per cent had the same complaint it is evident that inguinal pain or hernia is more than four times more frequent in the latter group.

REPORT OF CASES

Case I—A man aged 71 years was admitted to the Clinic complaining of pain in both inguinal regions for which codeine had been given on occasion. On physical examination a left inguinal hernia was felt. When the patient first was seen in the Clinic he gave no history of urinary difficulty. Because of a 1+ enlarged prostate consultation was requested. After careful questioning in the Department of Urology he admitted nocturia of three or four times diurnal frequency sometimes every thirty minutes a small stream and quite severe urgency.

Case II—A man aged 69 years was admitted to the Clinic complaining of pain in the right groin of three years duration. A diagnosis of hernia had pre-

viously been made but because of his advanced age and the duration of his symptoms he had consistently refused operation. He had been an office clerk until he retired about eight years previously.

On physical examination bilateral inguinal hernias were felt. In his history he volunteered no urologic complaints. The prostate was felt to be 1+ enlarged. Consultation was requested and on careful questioning in the Department of Urology he admitted a nocturia of one to four times a diurnal frequency of every hour marked urgency and incontinence on several occasions. Intravenous urograms revealed a marked residual urine.

CASE III—A man aged 76 years was admitted to the Clinic complaining of hernia of three years' duration. He had been an office worker all his life. He gave a history of having had some straining and diminution in the size and force of the stream for the last three years. After detailed questioning he admitted a nocturia of one or two times dribbling a small stream and he noted that the prostate gland was felt to be approximately 1+ enlarged. On cystoscopic examination the bladder was markedly changed as a result of urinary obstruction. A transurethral prostatectomy was carried out. 30 gm. of prostatic tissue being removed. There was immediate relief of his inguinal bulging and pain.

CASE IV—A retired banker aged 74 years was admitted to the Clinic complaining of constipation of three to four months' duration. On first questioning he said that he had no urinary difficulty and admitted a nocturia of only one time and a diurnal frequency of three or four times.

Three months after his first admission to the Clinic he developed an incarcerated left inguinal hernia and required emergency relief of this difficulty. A small right inguinal hernia which was causing some discomfort was also present. He was seen in urologic consultation because of prostatic enlargement. A transurethral prostatectomy was performed. 40 gm. of prostatic tissue being removed. Three months postoperatively the constipation was relieved and he was no longer troubled by the right inguinal hernia.

CASE V—A man aged 60 years was admitted to the Clinic complaining of pain in the lower abdominal area. He volunteered no history of urologic difficulty. A complete gastrointestinal study was carried out with entirely negative results. The lower abdominal discomfort persisted in spite of bowel management, and six months after admission to the Clinic he was seen in urologic consultation. In addition to the primary complaint he now complained of marked dysuria, nocturia of one to three times, diurnal frequency every two hours, marked urgency and dribbling.

The bladder was distended to three fingers above the symphysis and the suprapubic area was very tender to palpation. A transurethral prostatectomy was carried out. 6 gm. of prostatic tissue being removed. The bladder showed first change consisting of trabeculation and cellulose formation. The obstruction was due to a bladder neck contracture. The suprapubic discomfort was almost immediately relieved.

HISTORY

An adequate physical examination preoperatively is a well recognized essential, however, a prostate which rectally may feel normal in

size and consistency may be the cause of definite urinary obstruction by intra urethral or intravesical protrusion of the gland. In these cases reliance must be placed on a carefully taken history.

Terms commonly used by a physician may not extract an accurate account of the patient's genito urinary status. Misunderstanding of the following terms is especially prone to occur.

Nocturia—Every urologist at some time has been told by a patient that he does not get up at night to void and later after closer questioning he has discovered that the patient keeps a bottle at his bedside and awakens to void as many as seven times in the night. In the strict sense of the word however he never gets up at night to void. The question should be: How many times do you awaken at night to pass water?

Diurnal Frequency—The question: Do you pass water frequently during the day? may be answered in the negative because the patient does not know what is meant by frequently. A much better and more revealing question is: Do you pass water every hour during the day?

Urgency—The word urgency has no meaning to some patients. Ask the question: When you feel you must pass water do you have to go immediately or can you put it off?

Hesitation—Again this word has no meaning to most patients and it is better to say: When you go to pass water does it come right away or must you stand a while and strain?

Decrease in Size and Force of Stream—Because of the previously mentioned insidious onset of prostatism a patient frequently feels that his stream is good and adequate until there is total obstruction. A simple question such as: Do you pass a good stream? is not sufficient. The best method is that of comparison for example: When you were a boy your stream had excellent force. Does it have that amount of force now?

CONCLUSIONS

Inguinal discomfort and a potential hernia developing late in life should be recognized as a possible early manifestation of prostatism.

Inasmuch as obstruction of the urinary stream can be caused by a prostate which rectally feels normal in size emphasis must be given to a carefully taken history.

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THE USE OF MORPHINE NEOSTIGMINE (PROSTIGMINE) FOR THE RELIEF OF POSTOPERATIVE PAIN

(A Preliminary Report)

LEO V. HAND AND FRANCIS J. AUDIN

SLUGHTER and his co workers^{1, 2} have published laboratory and clinical results on the potentiation of morphine by the addition of neostigmine methylsulfate (prostigmine).³ Their primary problem was reducing the dose of morphine but still maintaining effective analgesic activity. In Slaughter's⁴ recent report he states that the results of LaBarrie,⁵ Bernheim and Bernheim,⁶ Wright,⁷ Winter⁸ and his own investigations indicate that morphine acts very much like a cholinergic drug, both peripherally and in its effect on pain. These investigators have demonstrated that the activity of morphine is enhanced by a cholinergic drug (prostigmine) and that its activity is reduced by an anticholinergic drug (atropine).

As the use of the modified Hardy Wolff Goodell pain threshold apparatus Slaughter reports a definite potentiating effect of prostigmine on morphine in a series of laboratory and clinical investigations. To quote a recent report⁴:

When the per cent change of pain threshold activity is plotted against time it can be shown that prostigmine alone has no pain threshold raising activity; in fact pain threshold values were decreased when this drug was administered by itself. Further, the combination of 8 mg. of morphine plus prostigmine had a greater effect in raising the pain threshold than did 16 mg. of morphine alone. And certainly the combination is far superior when compared with the effects of 8 mg. of morphine alone. In analyzing the data the effects of the doses only during the first two and a half hours are included. We found that this period covered the peak of effects. After this period of time the effects of the drug either remained unchanged for a while or gradually diminished. The combination of the two drugs (morphine 8 mg. plus prostigmine 0.5 mg.) also resulted in a more rapid rise in the pain threshold.

In the same report Slaughter states that the intensity of certain side reactions such as pruritus, somnolence, diminished time perception and muscular weakness are directly proportionate to the size of the dose of morphine. With a small dose of morphine the symptoms are less pronounced and with a large dose more severe.

The following conclusions are drawn from this report:

1. Adequate relief from pain is obtained from smaller doses of morphine combined with prostigmine.

Prepared by Hoffman-La Roche Inc., New Jersey

2 Certain undesirable side effects such as muscular weakness, nausea and diminished time perception are reduced.

As a result of these conclusions we elected to make a comparative clinical study of morphine-prostigmine and morphine alone as postoperative medications in a large group of patients. We realize that the age, weight, sex and physical state of the patient, type of anesthetic and operation are important factors influencing any medication for the relief of pain. In our final report these factors and their influence on each type of medication will be reviewed. In this preliminary report a comparison of medications will be made only with reference to the type of operation. In order best to evaluate the clinical efficiency, this comparative study was limited to patients who had undergone what might be considered major abdominal procedures.

These operative procedures usually result in moderate to severe pain of two or more days' duration. Early in our experience a few patients (10 to 15 per cent) had inadequate pain relief according to our standards with the first compressed tablet of morphine-prostigmine. These compressed tablets contain 8 mg ($\frac{1}{8}$ grain) of morphine plus 0.5 mg ($\frac{1}{120}$ grain) of prostigmine. In order to insure adequate pain relief an additional quantity of 8 mg ($\frac{1}{8}$ grain) of morphine now is given routinely with the first tablet of morphine-prostigmine. At the present time routine orders for postoperative medication with morphine-prostigmine are: (1) One tablet of morphine-prostigmine every four hours subcutaneously p.r.n. for pain; (2) morphine $\frac{1}{8}$ grain to be added to the first postoperative dose of morphine-prostigmine. If this medication is inadequate, additional medication is given. When morphine alone is employed the quantity ordered varies from $\frac{1}{6}$ to $\frac{1}{4}$ grain subcutaneously every three to four hours p.r.n. for pain.

In this preliminary report we shall consider only the records of the first 100 patients in each group. Patients who received morphine-prostigmine will be reported as Group A, and patients who received morphine alone will be reported as Group B.

For each patient the average total quantity of medication given, presence of relief from pain and duration of effect are recorded on a twenty-four hour basis for two days. This information was obtained from the nurses' progress notes as well as from the patient.

Of the three considerations, the review of relief from pain possibly might be considered to be the least accurate. This information depends usually on the acuity of the patient, which varies widely. It is logical to assume that a patient with pain will inform the nurse and seek relief. The small percentage of patients with the mistaken impression that they must endure pain is probably the same in both groups. The usual error was noted in the occasional employment of analgesic doses of medication for somniferous purposes. Again we may assume that the incidence of this was approximately the same in both groups.

COMPARATIVE RESULTS FROM THE USE OF MORPHINE PROSTIGMINE AND MORPHINE ALONE FOR THE RELIEF OF OSTEOARTHRAL PAIN

Operative	Group A (Morphine-Prostigmin)										Group B (Morphine-Al)										Group C (Morphine-Al)										Group D (Morphine-Al)										Group E (Morphine-Al)										Group F (Morphine-Al)										Group G (Morphine-Al)										Group H (Morphine-Al)										Group I (Morphine-Al)										Group J (Morphine-Al)										Group K (Morphine-Al)										Group L (Morphine-Al)										Group M (Morphine-Al)										Group N (Morphine-Al)										Group O (Morphine-Al)										Group P (Morphine-Al)										Group Q (Morphine-Al)										Group R (Morphine-Al)										Group S (Morphine-Al)										Group T (Morphine-Al)										Group U (Morphine-Al)										Group V (Morphine-Al)										Group W (Morphine-Al)										Group X (Morphine-Al)										Group Y (Morphine-Al)										Group Z (Morphine-Al)										Group AA (Morphine-Al)										Group AB (Morphine-Al)										Group AC (Morphine-Al)										Group AD (Morphine-Al)										Group AE (Morphine-Al)										Group AF (Morphine-Al)										Group AG (Morphine-Al)										Group AH (Morphine-Al)										Group AI (Morphine-Al)										Group AJ (Morphine-Al)										Group AK (Morphine-Al)										Group AL (Morphine-Al)										Group AM (Morphine-Al)										Group AN (Morphine-Al)										Group AO (Morphine-Al)										Group AP (Morphine-Al)										Group AQ (Morphine-Al)										Group AR (Morphine-Al)										Group AS (Morphine-Al)										Group AT (Morphine-Al)										Group AU (Morphine-Al)										Group AV (Morphine-Al)										Group AW (Morphine-Al)										Group AX (Morphine-Al)										Group AY (Morphine-Al)										Group AZ (Morphine-Al)										Group BA (Morphine-Al)										Group BB (Morphine-Al)										Group BC (Morphine-Al)										Group BD (Morphine-Al)										Group BE (Morphine-Al)										Group BF (Morphine-Al)										Group BG (Morphine-Al)										Group BH (Morphine-Al)										Group BI (Morphine-Al)										Group BJ (Morphine-Al)										Group BK (Morphine-Al)										Group BL (Morphine-Al)										Group BM (Morphine-Al)										Group BN (Morphine-Al)										Group BO (Morphine-Al)										Group BP (Morphine-Al)										Group BQ (Morphine-Al)										Group BR (Morphine-Al)										Group BS (Morphine-Al)										Group BT (Morphine-Al)										Group BU (Morphine-Al)										Group BV (Morphine-Al)										Group BV (Morphine-Al)										Group BW (Morphine-Al)										Group BX (Morphine-Al)										Group BY (Morphine-Al)										Group BZ (Morphine-Al)										Group CA (Morphine-Al)										Group CB (Morphine-Al)										Group CC (Morphine-Al)										Group CD (Morphine-Al)										Group CE (Morphine-Al)										Group CF (Morphine-Al)										Group CG (Morphine-Al)										Group CH (Morphine-Al)										Group CI (Morphine-Al)										Group CJ (Morphine-Al)										Group CK (Morphine-Al)										Group CL (Morphine-Al)										Group CM (Morphine-Al)										Group CN (Morphine-Al)										Group CO (Morphine-Al)										Group CP (Morphine-Al)										Group CQ (Morphine-Al)										Group CR (Morphine-Al)										Group CS (Morphine-Al)										Group CT (Morphine-Al)										Group CU (Morphine-Al)										Group CV (Morphine-Al)										Group CV (Morphine-Al)										Group CW (Morphine-Al)										Group CX (Morphine-Al)										Group CY (Morphine-Al)										Group CZ (Morphine-Al)										Group DA (Morphine-Al)										Group DB (Morphine-Al)										Group DC (Morphine-Al)										Group DE (Morphine-Al)										Group DF (Morphine-Al)										Group DG (Morphine-Al)										Group DH (Morphine-Al)										Group DI (Morphine-Al)										Group DJ (Morphine-Al)										Group DK (Morphine-Al)										Group DL (Morphine-Al)										Group DM (Morphine-Al)										Group DN (Morphine-Al)										Group DO (Morphine-Al)										Group DP (Morphine-Al)										Group DQ (Morphine-Al)										Group DR (Morphine-Al)										Group DS (Morphine-Al)										Group DT (Morphine-Al)										Group DU (Morphine-Al)										Group DV (Morphine-Al)										Group DV (Morphine-Al)										Group DW (Morphine-Al)									
	Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth Hours				Number	First Two to Four Hours				Second to Fourth																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		

From these individual patient records the average total dose presence of relief of pain and duration of effect were recorded in the accompanying tabulation for each type of operation. The figures on comparative results are enlightening and encouraging. We realize that this series of patients is small but we find that certain observations and results stand out and are continuing in our larger series.

The average daily dose of morphine required for comparable relief from pain is considerably less in Group A in both the first and second twenty four hour intervals [30 mg ($\frac{1}{2}$ grain) and 20 mg ($\frac{5}{16}$ grain) in Group A as compared with 50 mg ($\frac{3}{4}$ grain) and 35 mg ($\frac{1}{2}$ grain) in Group B or approximately 15 mg ($\frac{1}{4}$ grain) of morphine per day per person]. In patients who had undergone biliary tract surgery gastric and abdominoperineal resection the quantity necessary for pain relief was approximately one half

In our series this represents a difference of 15 gm ($2\frac{1}{2}$ grains) of morphine per day. This daily difference in morphine has a two fold importance. For the patient the small quantity lessens the undesirable side effects prone to occur when larger doses are employed. This may be a contributing factor in lessening the tendency to addiction. For the hospitals and institutions this represents a financial saving (the costs are approximately the same for a tablet of morphine prostigmine and a $\frac{1}{8}$ grain tablet of morphine).

The time interval from the subcutaneous injection to the relief from pain is appreciably shortened. Of the three considerations the total dose, the interval from injection to relief from pain and the duration of effect the interval of relief from pain is the least important as well as subject to error for the reasons mentioned earlier.

Reviewing the statistics on the duration of effect we find some interesting observations. As with quantity employed these figures are distinctly favorable to morphine prostigmine. In the group average it will be noted that the duration of relief from pain in the first twenty four hours for morphine prostigmine was six and a half hours. For morphine alone it was five hours. This increase in the duration of relief is even more striking in the second twenty four hour interval. Where the average was nine hours with morphine prostigmine it was six and two thirds hours with morphine alone.

Shortly after we began this series an interesting clinical observation was made. The surgeons, nurses and patients commented on the earlier presence of gas pains. These were frequently manifested on the second postoperative day. This discomfort usually was relieved by a rectal tube. With morphine alone these pains as a rule do not appear until the third day, are vague and are accompanied by some degree of distention. In many instances opiates were being administered injudiciously for the relief of this prolonged discomfort.

CONCLUSION

Our records on postoperative medication in this comparable study tend to substantiate Slaughter's conclusion that adequate relief from pain is obtained from smaller doses of morphine if combined with *prostigmine*.

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CLINICAL OBSERVATIONS ON LOW BACK AND SCIATIC PAIN

With Particular Reference to the Lumbosacral Joint and to the Intervertebral Disk Syndrome

G EDMUND HAGGART

From the bone and joint standpoint, it is believed that the most frequent site of low back pain is in relation to an unstable lumbosacral articulation. In the more stable type of this joint, the facets face laterally and medially; that is in the usual anterior posterior roentgenograms the observer looks through the joint space visualizing the articular surface between the facets (Fig 270 *a*). From this relatively stable joint, an infinite variety of facet relationships is observed. The extremely unstable articulation, as illustrated in the cephalad-caudad type of facet (Fig 270 *b*) may be present on one or both sides or

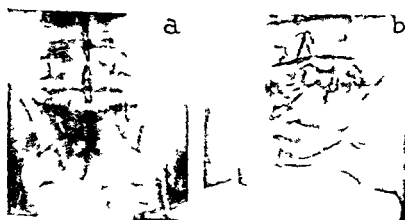


Fig 270—Roentgenograms of the lumbosacral articulation. *a* Internal and external facets that are regarded as of the more stable type *b* The cephalad-caudad type of unstable lumbosacral articular facet, around which are extensive bone changes. The arrows indicate the joint line.

there may be pronounced asymmetry with one pair of articular facets relatively stable and the other extremely unstable. The back of an individual who exhibits such mechanical instability is extremely susceptible to stress and strain and if this occurs the patient experiences a varying degree of low back ache and pain, often associated with sciatic radiation. In the more stable back subject to the same stress and strain, only slight symptoms or no disability results.

An additional mechanical factor that contributes to low back symptoms is an *acute lumbosacral angle* which when present intensifies any symptoms that may have occurred because of the instability of the

lumbosacral facets. The normal lumbosacral angle measures approximately 45 degrees with the horizontal plane (Fig 271 a) but in many individuals the line of relationship between the fifth lumbar and the



Fig. 271 a Lateral roentgenogram of normal and comparatively stable lumbosacral angle. The relationship between the first sacral and fifth lumbar vertebrae is at an angle of 45 degrees with the horizontal plane. b An acute lumbosacral angle. The relationship between the first sacral and the fifth lumbar vertebrae is an almost vertical plane which increases the susceptibility of the back to stress and strain.

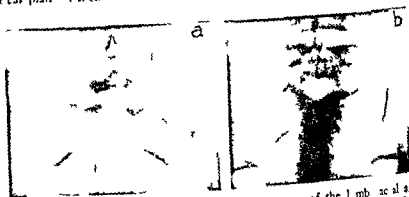


Fig. 272 a Dual anterior-posterior roentgenogram of the lumbosacral area, wherein the incomplete sacralization of the transverse processes is particularly well shown. b Forty-five degree angle view, described in text of lumbosacral region clearly demonstrates the incompletely sacralized fifth lumbar vertebra around which pseudoarthrosis has early become established. This roentgenogram also shows the rudimentary type of unstable lumbosacral joint which so commonly accompanies this bone anomaly. Note the excessive curvature of the sacroiliac joints.

first sacral vertebra is actually vertical (Fig 271 b) so that as pointed out by von Lachum⁸ there is a marked shearing strain at this point, that is a tendency of the fifth lumbar vertebra to slide downward and forward off the sacral platform.

Furthermore anomalous changes are often seen at the lumbosacral region of the spine as incomplete or complete unilateral or bilateral sacralization of the transverse processes of the fifth lumbar vertebra (Fig 272) In the former situation roentgenograms may reveal definite evidence of a bone reaction about the pseudo arthrosis Almost invariably in the presence of this anomaly the lumbosacral facets are rudimentary and hence unstable Such a mechanism results in the type of lumbosacral spine which is very susceptible to any injury It is to be emphasized however that bone anomalies are not per se a cause of symptoms but only a source of potential trouble if the back is subjected to strains or falls

Another mechanical fault observed in the lumbosacral spine is *spondylolisthesis* (Fig 273 a) In this condition there is failure of bone

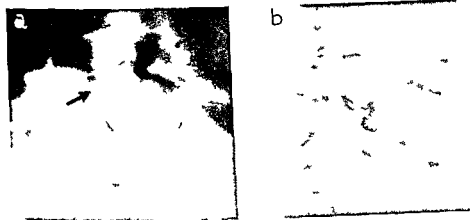


Fig 273—*a* Spondylolisthesis of the fifth lumbar vertebra Definite forward displacement of the body of the fifth lumbar vertebra on the sacrum The arrow indicates the bony defect in the pedicles *b* Prespondylolisthesis The defect of the posterior elements of the fifth lumbar vertebra is shown There is no forward displacement of the fifth lumbar on the first sacral vertebra If such a defect is suspected but not clearly visualized acute flexion and hyperextension films of the low back and hip joints usually reveal the pathologic condition

fusion due to a defect in the pedicles of the involved vertebra As a result of this defect the vertebral body tends to slide forward and downward usually resulting in an appreciable degree of low back disability This defect is most commonly observed in the fifth lumbar vertebra

The term *prespondylolisthesis* refers to an obvious failure of bone continuity in the posterior elements usually of the fifth lumbar vertebra but without any forward displacement of the vertebral body (Fig 273 *b*) Lateral roentgenograms centered on this region taken in (*a*) acute flexion of the low back hips and knees and in (*b*) hyperextension of the same areas demonstrate abnormal mobility of the involved vertebra if the diagnosis is uncertain In occasional instances

the body of the fifth lumbar is displaced posteriorly on the sacrum so called *reversed spondylolisthesis*. Again this situation is indicative of an unstable lumbosacral articulation usually productive of symptoms.

ROENTGENOGRAMS

In addition to the usual anterior posterior stereoscopic and lateral roentgenograms centered on the fifth lumbar vertebra it is well worth while to secure a 45 degree angle film which as the name implies is taken at an angle of 45 degrees the patient lying supine with the knees and hips flexed (Fig. 27). With this technic the sacrum is projected in the roentgenogram in a direct anterior posterior view which particularly well exhibits anomalous changes about the lumbosacral articulation as well as demonstrates variations in the sacro iliac joint. Failure of fusion of the posterior elements of the lumbosacral vertebra is likewise well shown.

SACRO ILIAC JOINT

It is my opinion that the sacro iliac joint is a relatively infrequent cause of low back symptoms always excepting specific pathologic conditions such as tuberculosis Marie Strumpell arthritis or localized sclerosing change in the iliac bone adjacent to the joint known as osteitis condensans ilii. In the more commonly encountered nonspecific type of involvement roentgenograms reveal a bilateral sclerosis or osteitis of both the iliac and sacral bone surrounding this articulation. The joint line is often obscured and irregular. Without question such disease may cause low back pain sometimes with sciatic radiation but it is not a frequent etiologic factor. In our experience removal of foci of infection often has alleviated the aches and pains.

The roentgenologic findings in the early stages of Marie Strumpell arthritis differ from the preceding description in that there is a bilateral *symmetrical* osteitis about the sacro iliac joints which if followed up exhibits a progressive ankylosis of that articulation. Thereafter the condition tends to affect the entire spine in progressive stages. Clinically these patients exhibit a different picture from the usual low back ache and sciatica. In the early cases the patient is usually a young male adult who complains not of disabling pain but of chronic persistent low back ache and in particular stiffness of the back.

INTERVERTEBRAL DISK PROTRUSION

In reviewing the histories of patients proved at operation to have a definite intervertebral disk protrusion the most characteristic story is that several years prior to admission either a severe lifting strain or a heavy fall on the buttocks or low back was sustained. While a history of trauma is not always obtained such trauma has occurred in a sufficient number of patients so that there appears to be a causal

relationship between the injury and later development of the disk protrusion. The most common symptom of which these people complain is recurrent sciatic pain. In some patients there has been more or less chronic low backache with occasional intervals of sciatic pain. Various

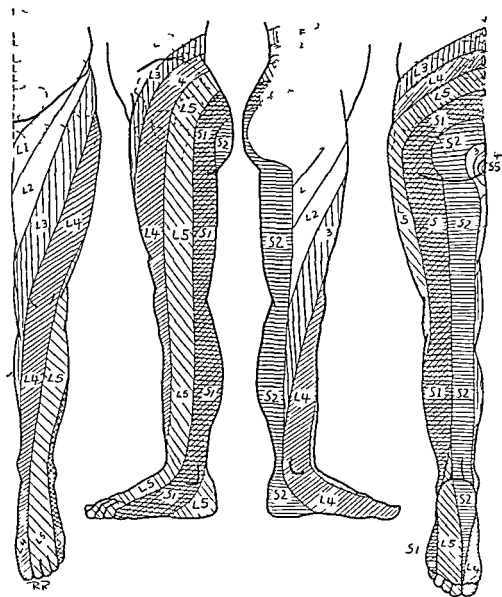


Fig 274—Keegan illustrates peripheral sensory distribution of the nerve roots of the lower extremity. Determination of variation in these tracts is most helpful in localizing the site of intervertebral disk protrusion.

types of conservative treatment have given so little relief that the patient demands more definitive therapy.

On examination the patient not infrequently exhibits a list of the trunk away from the side of the pain and there may be a considerable degree of muscle spasm of the low back with marked limitation of

motion of the trunk, especially in the standing position when attempting flexion or side bending due to pain referred down the leg. Localized tenderness over the site of what is later proved to be a disk protrusion may or may not be present. Leg raising tests if the patient is examined when in severe pain are almost always positive to a pronounced degree.

If the disk protrusion involves the first sacral nerve root the Achilles reflex may be reduced but I have not been impressed by changes in the reflexes of the lower extremity as especially helpful in the diagnosis. The same remark applies to the dynamics and total protein estimation of the spinal fluid. A most consistent clinical finding is the de-



Fig. 25—Still photograph shows the characteristic nictlike defect in the lipiodol column due to an intervertebral disk protrusion. The lumbar puncture needle which contained the mass of lipiodol is inserted directly in the midline and permits removal of the medium following fluoroscopic examination.

termination of sensory changes in the lower extremity based on neurologic studies by Keegan³ in a series of proved intervertebral disk protrusions. Figure 274 illustrates his analysis of the peripheral sensory distribution of various nerve roots in the lower extremities and hence permits localization of the nerve root involved.

A spinogram examination is distinctly worth while. The most comprehensive studies in our hands have been obtained with the use of lipiodol (Fig. 275). If this medium is employed it should certainly be removed after the technic described by Kubick and Hampton.⁴ The oxygen myelogram is often not satisfactory and in my opinion is difficult to interpret although with experience one naturally improves. To date we have not had the opportunity to employ pantopaque.

TREATMENT

The great majority of all patients with low back and sciatic pain first are treated conservatively. Such therapy primarily refers to development of the muscles of the low back and in particular the gluteal group with every effort made to improve the body mechanics and body posture. This conservative treatment is preceded by an interval of complete bed rest (twenty four hours a day) best carried out in a hospital. For the next ten days to two weeks exercises designed to increase the patient's activities should be instituted. A low back support should be utilized only in those patients who have extremely inadequate musculature or who of necessity must carry out employment that entails considerable stress and strain on the lower back. The objective is to build up the muscles to the point where no support is essential. The majority of patients improve on this regimen and in many instances become entirely free of symptoms. However a definite number of individuals either are in such severe pain when first seen that the above therapy is not feasible or else they previously have experienced adequate conservative treatment without help. In this group more radical treatment is warranted.

In severe disabling low back and sciatic pain wherein the complete examination including spinogram studies is negative for evidence of a disk protrusion relief may be obtained by a combination of back manipulation and perineural novocain injection of the sciatic nerve the technic of which procedure has been described elsewhere.¹ Adhesive skin traction by the Russell method also is helpful in these cases but manipulative therapy in the presence of a disk protrusion is distinctly unwise as we have had occasion to observe.

In those individuals who present definite clinical evidence of an intervertebral disk protrusion but in whom the lumbosacral joint appears to be stable hemilaminectomy with extradural removal of this protrusion is advised. In patients with instability of the lumbosacral spine in whom the findings also indicate a disk protrusion the combined operation is carried out namely hemilaminectomy and removal of the disk protrusion followed by fusion of the lumbosacral articulation. The technic of these operations previously was described in the *Surgical Clinics of North America*.² In the presence of persistent low back disability with or without sciatic radiation when studies indicate there is no disk protrusion but the roentgenograms reveal an extremely unstable lumbosacral articulation fusion of the lumbosacral joint should be performed. If there is doubt as to the presence of a disk protrusion the fourth and fifth lumbar space on that side should be explored. I particularly believe that in young persons with severe low back disability as well as in those patients who have to carry out heavy laborious work fusion of an unstable lumbosacral joint is indicated if conservative measures fail to give relief. The former group of patients who develop symptom in their early twenties usually will have

her difficulty as they go on in life while in the older group an able lumbosacral articulation is an ever present weakness prone to let in disability from low backache. In properly selected cases the fusions from fusion have been most satisfactory and the same remarks apply to patients with a diagnosis of intervertebral disk protrusion.

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AN UNUSUAL HERNIA PRODUCING ABDOMINAL PAIN

RICHARD B CATTELL AND B L ARONOFF

A direct hernia theoretically may occur at any position in the abdominal wall but usually is found at well recognized points of weakness such as in the umbilical epigastric and inguinal areas. We recently have encountered an unusual direct hernia above the inguinal region producing obscure gastro intestinal symptoms and are reporting this case for the following reasons (1) A survey of the literature since 1917 failed to reveal a report of any such hernia (2) this hernia was missed clinically and consequently the patient's symptoms were minimized (3) such a hernia could be overlooked easily at the time of surgery (4) it must be considered as traumatic in origin and (5) it produced abdominal pain thought to be of other origin

REPORT OF CASE

A man aged 51 years had been treated previously for a bladder infection and hypothyroidism. His chief complaint was abdominal pain which he could not localize. During the spring of 1940 he had fallen backward on the ice and felt something slip in the right side of the abdomen. Although he was tender in this area for a long time he did not think that he had hurt himself seriously. He said that the pain occurred periodically and had no relation to eating coughing or deep breathing. He thought that bending backward might cause accentuation of the pain. He had noticed that it was worse in the evening or when he was tired but was always relieved by rest or sleep.

Physical examination failed to reveal any abnormality other than hypothyroidism for which he was receiving thyroid extract. There was no abdominal tenderness or evidence of inguinal femoral epigastric or umbilical hernia. At the patient's insistence on roentgenologic examination a scout film of the abdomen was taken. This showed normal visceral outlines and no bony abnormality. The abdomen was large and pendulous. We thought that his symptoms might be due to muscular relaxation and so postural training abdominal exercises and an elastic support were advised.

The patient returned to the Clinic a month later with the thought that the pain was due to urinary infection. The urologic diagnosis was chronic prostatitis and the consultant did not think the genito urinary tract was causing the symptoms.

He returned six months later still complaining of pain in the abdomen and also external hemorrhoids for which local treatment was given. No evidence of hernia could be found.

On reexamination two years later the patient was found to have a large bulge in the right lower quadrant. This was partially relieved by a belt. A diagnosis of interstitial direct hernia was made the defect being described as a little above the internal ring.

At operation the usual incision for inguinal herniorrhaphy was made. Examination of the region surrounding the incision revealed no abnormalities. A semilunar hernia could not be found. However on examination of the conjoint tendon and the internal oblique muscle above it a sac about 5 cm. in length was noted. The defect in the wall was at least 2.5 cm. in diameter and about 4 cm. superior to the internal inguinal ring. The sac which passed downward between the fibers of the internal oblique muscle contained omentum but no intestine. The sac was freed up without difficulty, the contents reduced and the neck transfixed and tied. After removal of the sac, the transversalis fascia was closed and the muscle fibers of the internal oblique at the site of the hernia defect were sutured together with interrupted silk sutures throughout. The operation was completed as the usual Bassini repair.

Postoperatively the patient did exceedingly well and the cramping abdominal pain and soreness disappeared. Later check up examinations revealed that he had been relieved of symptoms.

DISCUSSION

The etiology of this hernia cannot be proved but the history and position suggest trauma. This hernia or any direct hernia could be produced by a sudden strain or direct injury. Such a direct hernia for example a semilunar hernia usually occurs at the site of emergence of blood vessels. This patient may have had a rupture of the transversalis fascia with resultant weakness and later herniation through the muscle. A congenital origin seems most unlikely.

The correct diagnosis was reached with much difficulty after three years observation. A number of conditions were considered and eliminated. The patient deserves a great deal of credit for returning for repeated examinations. Although the findings were consistently negative we believed his symptoms were real and on an organic basis.

In conclusion we consider this a most unusual type of hernia and one which as far as our survey goes has not previously been reported in the literature. It is well to reemphasize the fact that this patient continued under our care for three years with pain in his abdomen because this unusual hernia could not be demonstrated. It is also important to point out that at operation the sac was buried in fat and in the internal oblique muscle and might have been overlooked had we not been convinced of the presence of a hernia. The operative findings and the relief of pain prove that the hernia was the cause of his symptoms.

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HAIR BEARING SCALP FLAP FOR REPAIR OF UNILATERAL SCALP DEFECTS

GORDON B. NEW AND JOHN B. ERICH

GRATIFYING results of reconstruction of lost portions of the scalp can be secured only by employment of hair bearing pedicle scalp flaps. Unfortunately such grafts have a limited degree of usefulness since they may be applied in general only to defects of comparatively small dimensions. However even when extensive a defect which is unilateral and is located anteriorly can be repaired extremely well by means of a pedicle flap from the opposite side of the scalp (Fig 276). By this technic not only is the involved surface covered with hair but in addition a normal hairline across the forehead may be secured (Fig 277 *a* and *b*). As will be pointed out later in the case of a woman who has a defect involving one entire side of the scalp the pedicle to which we have made reference will be found to effect a remarkably good cosmetic result.

It is surprising how frequently one encounters persons who have sustained a unilateral loss of scalp tissue. We have seen several patients who had such defects which were the result of trauma particularly of third degree burns. When due to the latter type of injury the affected region is without hair is scarred badly and often is ulcerated because of the presence of dense avascular fibrous tissue (Fig 277 *a*). Briefly our plan of treatment consists in the elevation of a pedicle skin flap on the opposite and unaffected side of the scalp. This flap begins in the frontal and temporal regions and passes backward to the occiput. It must of necessity be elevated in stages (Fig 276 *a* and *b*) to insure an adequate blood supply through the pedicle at the time of transference of the flap. When ready for transplantation the distal portion of the flap is carried over to cover the injured region of the scalp (Fig 276 *c*). When healed in this position the unused part of the flap is severed from its distal portion and is returned to its original bed. The region in the occiput left denuded of scalp tissue must be

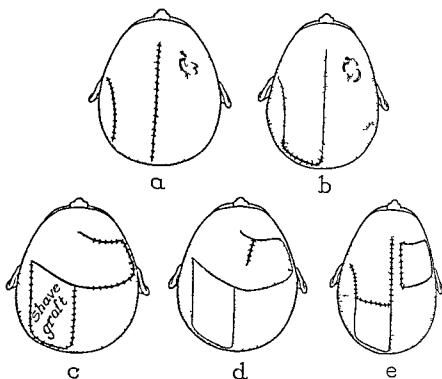


Fig 26—Repair of a unilateral scalp defect by means of a hair bearing scalp flap *a* First stage incision of the mesial and lateral margins of the flap *b* Second stage the distal pedicle of the flap is cut across *c* Third stage the flap is swung across and sutured to the margins of the defect and the denuded surface is covered with a shave graft *d* Fourth stage the flap is cut half way across *e* Fifth stage the flap is completely across and the pedicle returned to its original bed



Fig 277—Result of repair of scalp defect *a* Before grafting *b* After grafting

covered with a free Thiersch graft of skin. The details of this entire technic are described in subsequent paragraphs and should be read in close association with the illustrations.

The blood supply for the scalp flap under discussion is furnished by the frontal and temporal arteries on the side of the head opposite the defect. The mesial margin of this flap passes along the median line of



Fig 278—*a* and *b* Flap after second operation

the head while the lateral margin curves upward just anterior to the ear and then downward and backward (Figs 276 *a*, and 278 *a* and *b*). This flap should extend well down over the occiput (Fig 278 *b*) and its width is dependent largely upon the size of the defect to be repaired. The elevation of this flap and the transplantation of its distal end to the injured portion of the scalp require multiple operations to be described in the following paragraphs.

FIRST STAGE

After the patient's head has been shaved completely, the flap is outlined on the scalp with an indelible or skin pencil. The surface of the skin is painted with an antiseptic solution and sterile towels are draped around the field of operation. Incisions are made along the proposed lateral margins of the flap (Fig 276 *a*) and the scalp tissue intervening between these incisions is undermined completely down to the galea aponeurotica. This operative procedure leaves a long flap of skin completely free except for its pedicle attachments in the frontotemporal and occipital regions. Whether or not general anesthesia is employed, it is well to inject subcutaneously a 0.5 per cent solution of procaine hydrochloride containing epinephrine for its hemostatic effect; bleeding otherwise is profuse and difficult to control entirely by

the application of hemostats and ligatures to cut vessels. When hemostasis is complete the flap is returned to its original bed and sutured interrupted fine silk stitches being employed. Finally it is advisable to apply a firm dressing over the flap in order to prevent the formation of a hematoma. Such a dressing should not be disturbed for two or three days after operation.

SECOND STAGE

Ten to fourteen days after the first operation the distal pedicle is cut across thus severing the blood supply to the flap from the occipital region (Figs 276 *b* and 278 *b*). As in the first operation a solution of procaine containing epinephrine is helpful in controlling the hemorrhage. The incision is sutured with fine silk. Here again, a pressure dressing for forty-eight hours is highly desirable.

THIRD STAGE

With the passage of another ten to fourteen days the entire flap is elevated and is ready for transference to the defect (Fig. 279). However, should there be no free bleeding from the distal edge of the flap



Fig. 279—Flap elevated and ready for transference to the defect.

at this stage it is preferable to defer transplantation for another two week period. In preparation of the defect for reception of the flap the epithelial and scar tissues are excised in such a manner as to leave a raw surface into which the distal portion of the flap may be inlayed.

(Fig 280) When the bleeding from this raw surface has been controlled completely the flap is swung across to be sutured to the mar-



Fig 80—Preparation of the defect for reception of the flap



Fig 81—The flap is swung across and sutured to the margins of the defect

gins of the defect with fine black silk (Figs 276 *c* and 281) On completion of the foregoing procedures as well as those to be men-

tioned in the next paragraph a gauze dressing is fixed firmly with adhesive tape over the distal portion of the transposed flap thus preventing the formation of a hematoma below the flap.

The transference of the pedicle flap leaves a large denuded surface involving that region of the scalp from which the flap was elevated. This raw surface must be covered with a shave skin graft of moderate thickness obtained from the inner aspect of the thigh (Fig 276 c). The silk sutures employed to anchor this free graft to the edges of the denuded surface should be left long; subsequently they are tied over a thick pad of gauze which aids in fixation of the graft. In addition to the application of many strips of adhesive tape over the gauze dressing this technic thoroughly immobilizes the shave graft, an important factor that contributes to effective healing of the graft to the underlying gauze surface. This gauze dressing should be neither disturbed nor removed for a period of ten days.

FOURTH STAGE

Two weeks after transference the scalp flap is cut half way across, as is illustrated in Figures 276 d and 287. This incision which is sutured immediately greatly reduces the blood supply to the distal

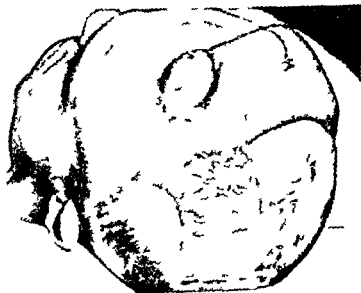


Fig. 8 —The flap is cut half way across.

portion of the flap from its frontotemporal pedicle. Such a reduction of blood supply prepares the flap for complete detachment from the pedicle at the next stage.

FIFTH STAGE

One week later the flap is cut completely across that is, amputated (Fig 783) The resultant free edge of the transplanted portion of the



Fig 783—The flap is cut completely across

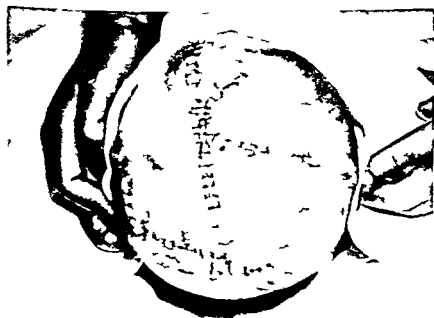


Fig 784—The pedicle is returned to its original bed.

flap is adjusted and sutured to the margin of the underlying scalp defect.

The pedicle or unused portion of the flap is returned to its original bed (Figs 276 c and 284). Before it is replaced however the scarred bands on its under surface must be cut and cross hatched so that the pedicle may be stretched out to its original contour. Furthermore any portion of the healed shave skin graft that interferes with replacement of the pedicle must be excised.

SIXTH STAGE

At the time of transference the margins of the flap can neither be cut nor be adjusted to produce a normal hairline across the forehead without seriously disturbing the blood supply to the flap. Consequently from the time of the fifth operation four to six weeks should elapse before surgical measures are undertaken to make the hairline of



Fig. 285



Fig. 286

Fig. 85 - Securing a normal hairline lateral view

Fig. 86 - Securing a normal hairline frontal view

the forehead on the reconstructed side symmetric with that of the opposite side. This adjustment requires excision of those portions of the transplanted scalp flap which extend forward beyond the normal hairline. As a result of this procedure one or more raw surfaces remain. These must be covered with thick shave skin graft taken from the inner aspect of the thigh or preferably with full thickness grafts obtained from the inner surface of the arm (Figs 285 and 286). If the raw surface is not too large a full thickness graft from behind the ear on the opposite side is ideal because the color of such a graft is similar to that of the forehead.

SEVENTH STAGE

As a result of the transference of the pedicle flap there remains a permanent bald region near the occiput. This bare region covered with

the shave skin graft is in men extremely conspicuous. However, it can be eradicated almost completely by repeated excisions of small portions of the skin graft and by the introduction of small islands of hair-bearing skin.

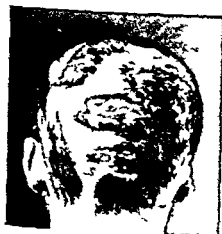


Fig. 87



Fig. 88

Fig. 87—Hair-bearing grafts to cover the bald region near the occiput.
Fig. 88—The hair covers the remaining bald surfaces.

hair-bearing flaps of skin from the scalp tissue adjacent to this bald region (Fig. 287). Ultimately when the hair in the occipital region has grown to sufficient length the small surfaces still left denuded of hair are invisible (Fig. 288).



Fig. 89—Result of repair of scalp defect. *a* Before grafting. *b* After grafting the hair covers the remaining bald surfaces completely.

COMMENT

It has been our experience that the operative procedures just described (seven stages) afford the most satisfactory means of repairing

unilateral scalp defects which are located anteriorly. Then too if the patient is a woman who has a defect that involves one entire side of the scalp this same surgical technic is to be recommended because it establishes a normal hairline across the forehead. The hair when allowed to grow long can be styled to cover the remaining bald surfaces completely (Fig. 289 *a* and *b*).

TREATMENT OF UNUNITED FRACTURES OF THE HIP

MELVIN S HENDERSON

A RECENT statement by Prof G R Girdlestone⁴ president of the British Orthopaedic Association is pertinent to the subject under consideration. He said: "In the past the great majority of these fractures [fractures of the neck of the femur] failed to unite; this is still true even of those that are pinned, though here the majority is no doubt much smaller. I am of course referring to the total number in which the pinning has been carried out, for we know that in skilled hands the majority unite."

In the United States, owing largely to the efforts of such organizations as the American Medical Association, the American College of Surgeons and the American Academy of Orthopaedic Surgeons, an increased interest has been aroused in the treatment of fractures. This is evidenced by the establishment of fracture services in our teaching and municipal hospitals. Whether the fracture service is under the leadership of the orthopedic surgeons or the general surgeons is unimportant. The fact that fractures receive special consideration by interested surgeons means that the services rendered will be better.

Imperfect reduction or failure to maintain reduction by adequate internal or external fixation is probably the chief cause of nonunion in fractures of the femoral neck. Of equal prominence as an etiologic factor is failure to make the diagnosis. Far too often an injury to the hip is called a sprain; no roentgenograms are made and the golden opportunity for early treatment slips by. Any injury to a hip should be considered a fracture unless proved otherwise by good roentgenograms.

In the last few years we have seen an increasing number of fractures, not only of the neck of the femur but other fractures of the long bones as well, that have failed to unite because of over pulling (distraction) when skeletal traction was used. When skeletal traction is used, the danger of too much traction on fractures is not appreciated by the medical profession at large. It is a definite etiologic factor in ununited fractures today.

In a certain percentage of persons the blood supply to the head of the femur is meager and a fracture through the neck of the femur may cause just enough injury to the blood vessels going to the head of the bone to deprive it of its nourishment. If union develops in such a case late atrophy of the head follows. The blood supply to the head and neck comes from three sources. Some few vessels may find their way up from the nutrient artery of the femur but the largest blood

supply comes from the internal and external circumflex arteries to the capsule. These vessels arise from the femoral artery, the continuation of the external iliac. The third supply comes through a branch of the obturator artery (branch of the internal iliac artery). This artery pierces the bottom of the acetabulum and comes to the head inside the so-called ligamentum teres. Some authorities estimate that in 25 per cent of adults this vessel is missing. If this last named vessel is absent in a case of a fracture of the neck of the femur, there is a good chance that nourishment to the head will be lacking, and the stage is set for nonunion.

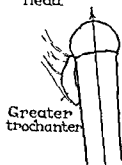
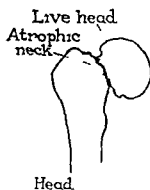
Lack of skeletal support is the cause of the disability in cases of nonunion of the hip. Some few patients attain firm enough fibrous union to enable them to get about comfortably with a cane or crutch and they should be left as they are.

SELECTION OF PATIENTS FOR SURGICAL TREATMENT

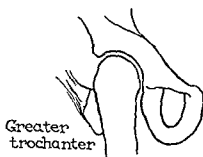
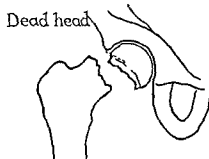
Because so many patients having fractures of the hip are elderly, each must be studied individually in order to determine whether he or she should undergo operation. Patients who have decompensated hearts or nephritis should not be operated on, but on the whole the patient who has been active and in good health up to the time of the accident will stand operation well. Since the surgeon has a wide choice of an anesthetic and in medical centers well trained personnel to administer it, age alone is not the determining factor as to whether surgical procedures should be undertaken. Records at the Clinic show a much lower average age for those patients in whom a bone graft was used than is found, for example, in patients subjected to the Whitman or Colonna procedures.

OPERATIVE PROCEDURES

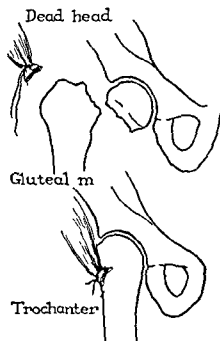
Operations for ununited fracture of the femur vary and must be fitted to the patient and not the patient to the operation. Local factors at the site of fracture decide the type of operation to be carried out. If the head is viable and a fair sized neck of the femur is left, some form of bone grafting operation should be considered. If the head is viable but the neck has been absorbed, the Brackett operation or some modification of it should be used (Fig. 290). If the head is dead there is no object in trying to get it to unite to the upper end of the femur, because the head will atrophy and collapse and static arthritis will develop. The patient then will be no better off than he was before operation even if union was secured. If the head is to be excised, the Whitman⁵ (Fig. 291), the Colonna³ (Fig. 292) or the Albee¹ operation (Fig. 293) may be used to furnish skeletal support. Somewhere in this group of procedures the high osteotomy described by McMurray



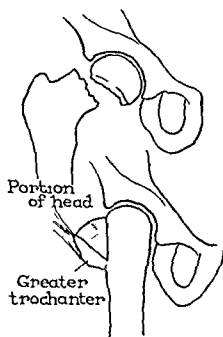
BRACKETT



WHITMAN



COLONNA



ALBEE

should be considered. At the Clinic we have had no experience with it and therefore I am in no position to evaluate it.

Bone Graft—The head of the femur must be viable and a good remnant of the neck must be present if a bone graft is to be used.

Extra articular Osteosynthesis by Bone Graft—If there is fibrous union and if the fragments can be brought into alignment with traction so that most of the shortening and all of the eversion of the leg is overcome then the bone graft may be put in place extra articularly (Fig 294). The operation is done blindly in that the joint is not

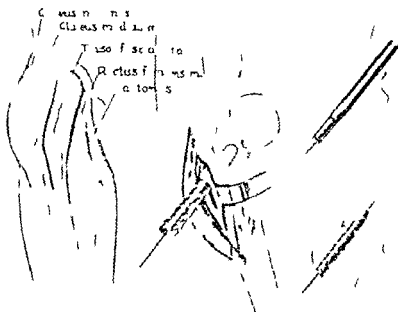


Fig 294—Extra articular osteosynthesis with bone graft

opened. A guide wire ($\frac{3}{16}$ inch or about 0.27 cm) is inserted through the wound from just below the trochanter through the trochanter and the neck of the femur up into the head. Anteroposterior and lateral roentgenograms are made to be certain that the line is correct. If the first wire is not properly placed a new line can be calculated and another wire inserted. The improperly placed wire is withdrawn. Over the correctly placed one is run a cannulate drill well up into the head of the femur. Over this wire is placed a piece of fibula about 4 inches (10 cm) in length. This graft is driven well into the head (Fig 294) and the guide wire is withdrawn. Roentgenograms must be taken to be certain that the graft is placed deep enough. The fibular graft before its insertion must be stripped of all muscle and the cortical

surface feathered so that the blood supply can more readily enter the substance of the bone (Fig 294) Roentgenograms are presented (Figs 295 and 296) of a woman aged sixty seven years who was treated by this method after eight months of nonunion

Articular Osteosynthesis by Bone Graft—If the fracture is such that the alinement mentioned cannot be obtained by traction it is necessary to expose the site of the fracture (articular osteosynthesis) A long incision is started just back of the anterosuperior spine of the



Fig 295—Nonunion of eight months duration The patient is sixty seven years of age

ilium (Fig 297) as it courses downward and backward to the posterior margin of the trochanter then sweeps upward and forward A flap is thus created with its convexity extending posteriorly The skin flap is lifted up drawn inward and fastened to the wall of the abdomen and the wall of the thigh by skin clips (Fig 297 c) By this method the hip can be exposed nicely and the skin of the groin is held out of the field The dissection is carried down between the tensor fasciae latae and the sartorius and the gluteus medius is stripped from the wall of the ilium for several inches The anterior surface of the joint is exposed and the rectus femoris is retracted inward The capsule is opened and the anterior surface of the neck of the femur the anterior margin of the acetabulum and the head of the femur are ex

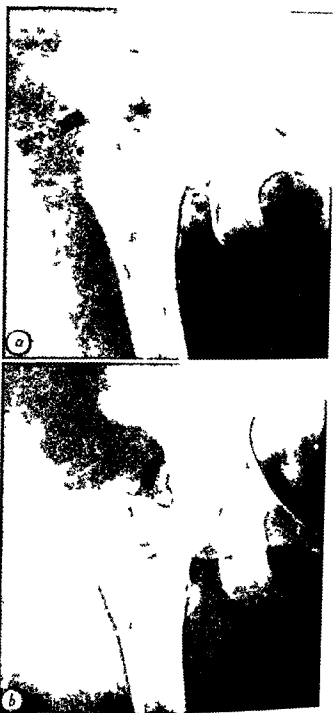


Fig. 96—Same case as Figure 95. *a*, Position of hip has been corrected and traction has been applied for one week. *b*, bony union fourteen months after extra-articular osteosynthesis with bone graft. The functional result was excellent.

posed. In cases in which ununited fracture has existed for long the dissection may be somewhat tedious and difficult because of the great thickening and fibrosis of the anterior portion of the capsule. By manipulating flexing and rotating the hip the site of fracture can be exposed more easily.

The fragments should be separated and all the fibrous tissue removed from between the head of the femur and the neck of the femur. After this is accomplished the fragments must be freshened until bleeding bone is encountered in each and then the fragments must be fitted accurately. Care must be taken not to chisel too vigorously and re-

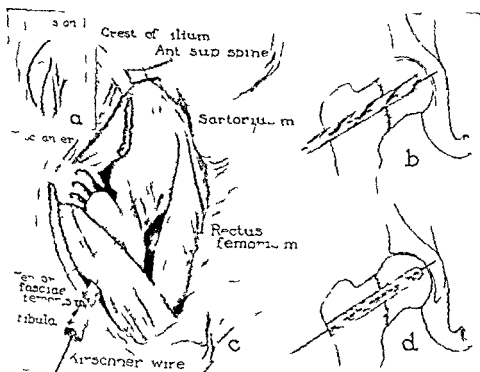


Fig 297—*a b c and d* Articular osteosynthesis with bone graft

move too much of the head of the femur because often the head is none too well supplied with blood and heavy chiseling and scraping may do damage. When the pseudarthrotic material has been excised and the fragments fitted the bone graft can be placed under visual control (Fig 297 *b* and *d*). The bone graft can be either a piece of the tibia or the fibula. I prefer the latter. It has been recommended that along with the bone graft a screw or nail be inserted as internal fixation. The diameter of the neck of the femur is not large and if it is filled full of bone graft and a screw or nail is added much of the blood supply and the internal structure of the neck may be destroyed.

External Fixation—Adequate external postoperative fixation must be

provided no matter which method of inserting the bone graft has been used I prefer a double spica cast which extends from the chest to the toes on the affected side the leg is abducted slightly and the foot and knee are held so that there is no eversion. On the nonaffected side the cast extends from the chest to the knee. It is astonishing how well elderly people tolerate this type of fixation. They can be turned over at intervals and thus the danger of pulmonary embolism can be lessened. The one bad feature of such a cast is the stiff knee that so often follows. I have tried having joints put in the cast at the knee but when the knee is flexed the quadriceps muscle is pulled and tends to move



Fig. 98—Nonunion of six months duration. *a* Before operation. *b* Six months after operation. Excellent function was obtained.

the fragments at the site of the fracture. So there is no compromise. The leg simply must be held firm until the bone graft has a chance to grow and this cannot be expected in less than eight to twelve weeks.

The Brackett Operation—The Brackett operation is applicable when the head of the femur is good but the neck is gone (Fig. 290). Brackett many years ago argued that the head of the femur might be saved even if the neck of the femur was atrophied. The Brackett operation depends for success on a viable head and the upper end of the femur being prepared so that the head rests securely on it in a position of

Since this article was written my colleague Dr. Ralph K. Ghormley has reviewed the Brackett operations performed at the Mayo Clinic.

valgus Nonunion of the neck of the femur of six months duration in the case of a man fifty eight years of age who was treated with the Brackett operation is shown in Figure 298

Technic—The fracture of the hip is exposed in the manner just described for use for bone graft The upper end of the femur is remodeled after the trochanter with its attached muscles has been chiseled off and drawn up out of the way The pseudarthrotic fibrous tissue is dissected out thoroughly and the fractured surface of the head of the femur is carefully freshened Then the remodeled upper end of the femur is put against the head the normal angle of 127 degrees being practically entirely obliterated The head thus sits on top of the shaft in extreme valgus If it is thought necessary the head may be fastened to the shaft with a screw introduced from below upward The head of the femur should be disturbed as little as possible After the position of extreme valgus is obtained for the head of the femur and the hip is placed in almost full abduction the trochanter with its attached muscles is brought down and fastened at a lower level on the shaft than it was before The tonicity and pull of the pelvofemoral muscles hold the upper end of the femur in position firmly against the head

A double spica cast is applied as described before with the leg on the affected side in almost full abduction and the foot held upright to prevent eversion At the end of about six weeks this cast is split so that the top half can be removed The patient then is allowed by a pulley arrangement on an overhead frame to begin passive movement which consists of flexing the knee and thus flexing the hip The patient also is encouraged to contract the quadriceps muscle At the end of three months following the Brackett operation the head of the femur is usually firmly enough united to permit the patient being up on crutches Weight bearing is assumed gradually in a few months more Throughout the course of convalescence roentgenograms are made frequently enough so that the surgeon has knowledge of just what is taking place at the site of fracture

Whitman Reconstruction Operation—The Whitman reconstruction operation is applicable in cases in which the head of the femur is dead and there has been atrophy and absorption of the neck The operation consists of the anterior incision and lifting up of the trochanter with its attached muscles and excision of the head of the femur The neck of the femur then is remodeled and put in the acetabulum This procedure provides skeletal support for weight bearing The trochanter with its attached muscles then is brought down and fastened at a lower level (Fig 291) The accompanying roentgenograms show nonunion of ten months duration (Fig 299 a) in a woman forty eight years of age and the result thirteen years later (Fig 299 b) This

patient has done her work about the house for years without a cane or crutch but does use a cane out of doors

Colonna Operation—The Colonna operation is similar in principle to the Whitman operation with the exception that instead of lifting up the trochanter the muscles are dissected carefully from the trochanter and held together by a sort of purse string suture. The head of the femur is then excised and the denuded upper end of the trochanter is placed in the acetabulum. The muscles gathered together by the purse string suture are then brought down and fastened to the shaft of the femur through drill holes placed in it at a lower level (Fig. 29)



Fig. 29—Nonunion of the I p of ten months duration as Preoperative view thirteen years after Whitman operation

Albee Reconstruction Operation—The Albee reconstruction operation consists of removal of the head of the femur. It is freshened and made to fit into a cleftlike opening made by longitudinal osteotomy. The chisel is introduced from above downwards partially through the trochanter and the trochanter is pried outward (Fig. 293). The operation has the advantage that it provides a better fulcrum for the trochanteric muscles. The upper end of the femur is placed in the acetabulum as it is in the Whitman reconstruction operation.

Fixation for the Whitman, Colonna and Albee Operations—In the reconstruction operations just mentioned the Whitman, Colonna and Albee postoperative fixation must be provided as in the other procedures but is maintained for a shorter period. After three weeks to month movement is permitted.

RESULTS OF OPERATIONS

Following the bone grafting operations and the Brackett operation it is not at all unusual to see patients who have practically full motion with excellent function. After reconstruction operations in which the head of the bone is sacrificed there is definite limitation of motion and usually the patient is forced to use a cane. The one point common to all the operations is that skeletal support is re established.

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CHRONIC SCLEROSING OSTEITIS (SCLEROSING NON SUPPURATIVE OSTEOMYELITIS OF GARRE)

The Differential Diagnosis from Syphilitic Lesions of Bone Sclerosing Osteogenic Sarcoma Paget's Disease of Bone (Osteitis Deformans) Subperiosteal Ossifying Hematoma Osteitis Fibrosa Cystica Heman-
gio endothelioma (Ewing's Sarcoma Endotheliomyeloma) and Meta-
static Carcinoma

HENRY W. MEYERDING

CHRONIC sclerosing osteitis is one of the inflammatory diseases which must be considered in the differential diagnosis of benign and malignant lesions of bone. In the majority of instances the general practitioner sees the patient during the acute stages of the disease and is not so readily confused in making his diagnosis as those that may be called upon for an opinion after the acute symptoms have subsided. Garre in 1893¹ in a paper on acute infectious osteomyelitis began the section "The sclerosing nonpurulent form" as follows:

I should like to designate as sclerosing forms those infectious forms of osteomyelitis which leave behind solely swelling and thickening of bone without formation either of pus or of fistulas. They begin in a typical way having an acute onset in the majority of cases, and proceed with high fever, swelling of the extremity, pain and swelling of the bone even with considerable infiltration of the soft parts which leads one to expect the speedy formation of an abscess. Instead the infiltration regresses slowly while the fever has dropped previously and while the patient proceeds slowly to cure nothing remains but greater or lesser swelling of the bone.

Garre then quoted a report of three cases observed by Professor Bruns. The report had been published by the attending physician Dr. Klupfel:

In the course of fourteen months three children in the same family became ill with acute infectious osteomyelitis. 1. A boy nine years of age following trauma became ill with suppurative osteitis of the tibia with abscess in the popliteal space. He died within a few days with meningitis and metastasis. The fever remained constantly high. On postmortem examination the diagnosis was confirmed. 2. Four months later a girl five years of age became ill in consequence of a cold with osteomyelitis of the tibia accompanied by formation of foul pus in the knee joint. Death occurred after a few days. 3. Finally a boy twelve years of age became ill. Soon after a blow on the right thigh pain, swelling and a fever up to 40.8 [C.] developed. A diagnosis of osteomyelitis was made and according to the procedure of Kocher a 1 per cent solution of carbolic acid was injected into the periosteum which was inflamed and swollen and sodium benzoate was given by mouth. After

six days the fever had fallen to 39.6 [C.] Delirium and slight diarrhea occurred. An incision of the swelling in the posterior lower part of the thigh was contemplated but was not made because there was no definite fluctuation. After a short exacerbation of the fever the swelling of the thigh decreased and the painfulness disappeared but more and more it was possible to feel the thickening of the lower part of the femur above the external condyles. Four months after the beginning of the disease the right thigh was still 5 cm. thicker than the left or healthy one. The swelling never came to a head. The soft parts were no longer infiltrated.

The last case belongs without doubt to the sclerosing nonpurulent form of acute infectious osteomyelitis. The first symptoms offer a classic picture of the acute form of osteomyelitis. Only the outcome differs in so far as the expected formation and discharge of pus did not occur.

Garre discussed various other forms of osteomyelitis and the facts that sclerosis may occur in more than one region in the same case and that sinuses may develop in some regions. I believe that the chief difficulty of differential diagnosis lies in those cases in which nonsuppurative sclerosing osteitis occurs singly and without drainage.

ACUTE STAGE OF SCLEROSING OSTEITIS

One may dispense with a consideration of differential diagnosis in the acute stage of sclerosing osteitis for it is obviously an acute infection of bone with local and general manifestations which may not differ in onset from the ordinary cases of acute osteomyelitis. What the future holds for the patient suffering from chronic osteomyelitis is problematic at this time and may be greatly influenced by the efficacy of the new sulfonamide drugs and penicillin. I believe that with the early and more frequent use of these agents at the onset of symptoms a new era in the successful treatment of all forms of osteomyelitis is at hand. Many patients otherwise destined to a prolonged illness with drainage, formation of sequestra and disability in the future will become free of abscess and well thanks to these newly discovered drugs. It is already discernible that the use of these drugs has made a distinct change in the severity of symptoms and complications. When unlimited amounts of penicillin become available for the civilian population and it is administered early, I believe that further progress is bound to follow. Let us hope that the chronic stage of the disease and disability may be entirely prevented. In cases in which a definite region of destruction is observed or in which abscess or sequestra occur and show in the roentgenogram, drainage, dishing or saucerization, packing with gauze impregnated with sulfathiazole and application of a large dressing of gauze and cotton are the measures indicated in my opinion.

CHRONIC STAGE OF SCLEROSING OSTEITIS

Pain is the first symptom of the chronic stage of sclerosing osteitis localized boring pain that is located deep in the bone that is almost always worse at night than during the day that is usually persistent but may be of lesser intensity at some times than at others that is aggravated by exposure trauma or debilitating illness and that lasts for months or years. Localized swelling of a hard fixed type with tenderness on firm pressure may be palpated on one side or a spindle shaped mass usually involving the shaft of the femur or tibia is soon observed. These swellings of bone may remain stationary or may enlarge gradually for a period of weeks but an important point in differential diagnosis is that they remain the same without further growth for long periods sometimes many years. Although the growth remains stationary the pain persists. The health of the patient remains good. There is no increase of the leukocyte count after the acute symptoms have subsided. The concentration of hemoglobin and the erythrocyte count may remain normal or mild secondary anemia may occur. As a rule there is no disability and the function of neighboring joints remains normal. The skin and soft tissues remain loose and are easily movable and the veins do not become enlarged. At times there may be appreciable local heat but frequently there is a normal temperature over the site of the lesion.

Thus the patient consults a physician because he has a swelling and pain in an extremity usually located in the femur or the tibia the initial illness may have been forgotten completely. On inquiry previous illness may be denied in some instances but I have found that persistent inquiry frequently disclosed illness or local injury. The history is of great importance and although children may not remember the parents may recall a history of mild illness with local trauma preceding the onset of symptoms. In many cases when I have inquired about such matters I have been told that there was no preceding illness but when some relative reminded the patient thereof such etiologic factor became evident. Thus one may be able to make a diagnosis of chronic sclerosing osteitis without a roentgenogram from a good history and chronic painful swelling of bone that has become stationary.

Much of the confusion which has existed as to the diagnosis of malignant tumor osteitis deformans syphilis and so forth on the one hand and chronic sclerosing osteitis on the other hand has been produced by those who have had little experience in the interpretation of the roentgenograms. It is advisable to have consultation of an orthopedic surgeon and of a roentgenologist before one makes a diagnosis of a malignant lesion and advises radical surgical treatment. In some instances even the expert roentgenologist and surgeon may have difficulty in interpreting the roentgenograms correctly and then biopsy is

indicated. If one remembers the slow growth, chronicity without evidence of general symptoms, the frequent location in the shafts of bone, the lack of invasion of soft tissues in the late stages of sclerosing osteitis, the lack of periosteal thickening and the lack of Codman's triangle, so common in cases of sarcoma, one will have the essentials of roentgenologic differentiation. Sclerosing osteitis localizes in the shaft, first producing a thickening in the cortex on one side and later a circumscribed cortical thickening which finally closes the medullary cavity. The presence of small areas of decreased density is fairly common in well prepared roentgenograms and even small spicules of dead bone sequestra are visible at times. There is no doubt in my mind what would be found and I have frequently demonstrated that these areas represent foci of infection which contain small sequestra. Cultures of material from such foci are frequently sterile but in some instances I have been able to obtain staphylococci. The pathologist may report chronic inflammatory tissue where bits of soft tissue are obtained. Pus is very rarely observed. At times several areas of decreased density are visible in the roentgenogram. In stages of recent infection or exacerbation a slight thickening or roughening of the periosteum may be visible. There is no thickening of soft tissue to be seen in the late stages of sclerosing osteitis. Metastasis does not appear in the lungs (Cases I and II).

SYPHILIS OF BONE

Syphilis of bone may occur at any age but those cases in which the observations simulate those characteristic of chronic sclerosing osteitis occur commonly among older patients. Pain may or may not be a prominent symptom and when present is usually less severe than in cases of chronic sclerosing osteitis. Local heat, tenderness and thickening of soft tissue are frequently present. A history of previous syphilitic infection or clinical and laboratory findings or in the absence of these the resort to a therapeutic test by intensive antisyphilitic measures will clear up the diagnosis.

Roentgenograms may show both sclerosing (osteoplastic) and osteolytic areas. Areas of decreased density in cases of syphilis are more extensive than the small foci occasionally found in cases of sclerosing osteitis of Garre. Periostitis extends over larger areas of the diaphysis with layers of formation of new bone over the cortex and a hazy outline producing a cortical thickening which bows the shaft on the convex side. When this occurs in the tibia it gives rise to the typical saber shin of syphilis. However in cases of rickets also the thickening of the cortex is found on the convex side. Gummatous lesions show irregular regions of decreased density. Sclerosing and osteolytic proc-

esses occur simultaneously and are more likely to be multiple and the moth eaten appearance is seen more frequently in cases of syphilis than in cases of chronic sclerosing osteitis (Case III)

SCLEROSING OSTEOGENIC SARCOMA

The problem of distinguishing the sclerosing type of osteogenic sarcoma from sclerosing osteitis may present considerable difficulty. The age of the patient is of little value in distinguishing these two conditions since both lesions occur frequently before thirty years of age and either one may occur at any age. In cases of sarcoma pain may be less intense than in cases of sclerosing osteitis and tends to be more progressive as the tumor increases in size and involves the periosteal tissues. It is a characteristic sign of sclerosing nonsuppurative osteomyelitis of Garre that growth comes to a standstill whereas in cases of sarcoma the tumor continues to grow rapidly. In the former the soft tissues are not involved while in the latter they are invaded and distended until the skin is stretched and becomes shiny and the veins show engorgement. In cases of sarcoma there is in early stage of growth before involvement of soft tissue occurs which may tax the most skillful diagnostician's ability to distinguish it and not until operation has been performed and decalcification and microscopic study of the tissue have been done can the true nature of the lesion be determined. I have seen patients who have been advised to have amputation for sarcoma but who following operation have been proved to have sclerosing osteitis. On the other hand I have seen others that were considered to have sclerosing osteitis but who have been proved to have a malignant lesion.

It is well to remember that sarcomas occur most frequently at the end of long bones and that sclerosing osteitis of Garre occurs most frequently in the diaphysis. In cases of sarcoma atrophy begins early motion of the joint is impaired and disability and debility become progressively more apparent. Loss of weight cough with bloody sputum and evidence of metastasis are symptoms of a malignant lesion that are absent in sclerosing osteitis of Garre. In case of suspected sarcoma of bone it is always wise to have roentgenograms of the thorax since I have seen young patients apparently well and with no outward evidence of metastasis who have shown typical roentgenologic findings of pulmonary metastasis. Roentgenologically sclerosing osteogenic sarcoma in its early stages of growth may simulate sclerosing osteitis of Garre. It may be impossible to determine whether a sclerosing area in the cortex which has as yet not produced much change in the periosteum is due to one condition or to the other. However if the condition is sarcoma soon the periosteum is raised and the angle of Cod

man and the sun ray like calcified areas appear. While these areas are not diagnostic they are seen more frequently in cases of sarcoma than in those of syphilis or osteomyelitis. The cortex rapidly thickens the medullary cavity may be obliterated and the soft tissues show invasion. This power of invasion through all the tissues with accompanying osteoplastic deposits is encountered only in cases of sarcoma (Case IV).

PAGET'S DISEASE OF BONE (OSTEITIS DEFORMANS)

Osteitis deformans is a generalized disease that occurs among older people and produces enlarged and soft bones. When it occurs in the lower extremities it may result in bow legs, weakness and disability. It is insidious in its onset, is accompanied by aching pain and may not be discovered until a roentgenogram of the painful region discloses a bony change which may appear sclerotic and localized. It is this type of lesion that is sometimes confused with that of chronic sclerosing osteitis. The tibia and the femur are frequently affected as is also true in cases of sclerosing osteitis of Garre. The increase of size of the skull and the thickening of the cranial bones as noted in the roentgenograms explain the need for the patient's larger and larger headgear.

Backache is a common symptom of Paget's disease and the roentgenograms of the pelvis and the spinal column frequently demonstrate evidence of involvement of the bones in these regions. The lesion of the bone is more extensive than in cases of sclerosing osteitis of Garre. There may be multiple lesions. The lesion or lesions are characterized by enlargement with coarse lines of trabeculations running through areas of decreased density and a fuzzy appearance of the surface. Infection or fractures occur. The concentration of phosphatase in the blood is increased. Surgical treatment does not relieve the disease as it does in chronic sclerosing osteitis and its only value is the opportunity of getting sections of bone for microscopic diagnosis. Bone is absorbed and new bone is laid down. Vascularized connective tissue replaces bone forming elements and pathologists may report the tissue as indicating osteitis fibrosa cystica. Sarcoma may develop as a complication of Paget's disease of bone but I have never observed it as a complication of sclerosing osteitis of Garre (Case V).

TRAUMATIC (SUBPERIOSTEAL PAROSTEAL) OSSIFYING HEMATOMA

Trauma may give rise to localized swelling, pain and slight local heat with little or no general manifestation such as fever or leukocytosis. The periosteum may be raised or perforated and a collection of blood may form which in a few weeks becomes calcified and produces a hard, fixed mass. This mass may be tender, it does not enlarge

and the superimposed tissue may move freely on palpation. All of these features closely resemble the picture seen in cases of sclerosing osteitis; however, in cases of traumatic ossifying hematoma the bony enlargement is all formed outside the cortex, not within it, and as a rule the medullary space is not involved. I have observed cases in which such traumatic lesions in the shin caused swelling and pain which persisted for months. In time these lesions regress and pain and swelling tend to lessen. It is well to remember that the formation of bone may begin at the border of the hematoma, along the edge of the periosteum, leaving an area of lesser density in the region next to the cortex, and as the ossification progresses the bone fills in until a solid mass of bone is formed next to the cortex. In the majority of instances these regions of formation of bone do not have the same amount of local heat or tenderness as is found in some of the inflammatory lesions (Case VI).

OSTEITIS FIBROSA CYSTICA

The lesions of osteitis fibrosa cystica are of doubtful causation. They occur most frequently in youth, are attended by little or no pain, and are subject to fracture. The latter may be the initial symptom and occur following mild trauma. The bone may appear to be sclerotic in a considerable portion of the shaft, but regions of cystlike formation are seen; the cortex may be thinned and contain cysts and may be bulged outward. The periosteum appears uninvolved and its margin is usually clear cut. In cases in which the disease is advanced, the medullary portion of the bone may be obscured by areas of increased density and areas of lessened density. Bone is replaced by a fibrocystic formation which weakens the structure and which contains curved trabeculae of coarse appearance in the roentgenogram. The disease occurs frequently in the tibia and the femur and may occur as a single lesion or as a multiple form, the latter being known as von Recklinghausen's disease, which occurs in more than one bone. Pain is never as severe as that of sclerosing osteitis. Sarcoma may develop in fibrocystic lesions of bone and metastasis occur (Case VII).

HEMANGIO ENDOTHELIOMA (EWING'S SARCOMA, ENDOTHELIOMYELOMA)

This malignant neoplasm occurs most frequently in the first two decades of life and is characterized by the laying down of new bone subperiosteally in layers resembling those of an onion. It involves the diaphyses of the tibia and femur and is associated with intermittent symptoms of pain, fever, leukocytosis and swelling. It rarely involves the epiphyses. Its course is progressive and destructive changes are soon visible in the roentgenograms with or without involvement of soft tissue. Fractures occur frequently. Metastasis to other bones occurs

in later stages with gradual loss of strength, anemia and disability until death intervenes. Hemangio-endothelioma responds to irradiation therapy to such an extent that a therapeutic treatment becomes a diagnostic aid. I do not believe that this lesion will be difficult to distinguish in the great majority of cases by those who have had a great deal of experience in the treatment of tumors of bone and I would recommend a thorough course of irradiation in the cases presenting a problem of differential diagnosis.

When one has the opportunity to obtain sections of tissue the pathologist will make the diagnosis following microscopic study. The characteristic dense bone formation of sclerosing osteitis is lacking in the latter union like layer formation of bone is not seen and the medullary portion of the bone is not involved with bone changes of a destructive nature. The medullary portion of bone is replaced by dense appearing sclerotic bone growing in from the cortex in sclerosing osteitis. There is no microscopic similarity between the two conditions. The characteristic small round cells with fibrous stroma are typical of Ewing's sarcoma (Case VIII).

METASTATIC CARCINOMA

In metastatic growths from the prostate regions of increased density are found to occur most frequently in the pelvic bones, the lumbar segment of the spinal column, the ribs, the femur or any bone. These regions of osteosclerosis may be accompanied by regions of osteoporosis and result in weakening of the structure and fracture. Chronic backache may be the first symptom and the roentgenogram may show the first clue to the presence of malignant neoplasm of the prostate. The multiple lesions with dense production of bone present a mottled appearance with occasional enlargement of bone. These lesions are not frequently confused with sclerosing osteitis and the examination of the prostate will usually clear up the diagnosis. Metastatic growths from the breast may likewise be distinguished from sclerosing osteitis; there usually is a history of previous operation or the tumor may be palpated (Case IX).

TREATMENT OF SCLEROSING OSTEITIS

The treatment of sclerosing osteitis is surgical. The extent and type of operative procedure are dependent on the extensiveness of the lesion in the bone involved. Thus in an isolated region involving only a portion of the cortex, all or most of the involved bone may be removed by guttering, saucerization or dishing and the focus thus removed. In many instances drilling through such regions is sufficient to relieve symptoms but I prefer the more extensive removal of the affected bone whenever this is possible. In cases in which there was involvement of

the tibia I have employed the bone saw which permits the rapid removal of the affected portion of bone. Swabs of the cavity or particles of the wall of the cyst are sent to the bacteriologic laboratory for study but have seldom shown the presence of bacteria. The cavities are dusted with sulfathiazole and then closed. In the vast majority of cases primary closure has resulted in healing by primary intention.

When the entire cortex is involved a number of drill holes depending on the size of the sclerotic region may be passed through the bone or a guttering through the most available portion together with drilling may be employed. In such cases if the lesion is located in a weight bearing bone external fixation may be required for a short time so as to guard against possible fracture. If patients have had drilling operation or insufficient guttering of the involved bone re-operation may be performed and a more extensive removal of bone be employed with good result. Foci of infection may play a role in the causation and such foci evidently should be eliminated. The oral administration of sulfonamide drugs and the intravenous administration of penicillin have not been in practice a sufficient length of time to determine their efficacy in the chronic stages but in the acute stages it would appear to be advisable to use maximal doses in the hope of preventing the sclerosing changes.

COMMENT

Chronic sclerosing osteitis is recognized as a form of osteomyelitis. Clinically it is characterized by persistent sharp pain and enlargement of bone. Roentgenologically it shows dense sclerosis that usually occurs in the shaft of the tibia or the femur. The roentgenologist and the orthopedic surgeon experienced in disease of bone usually are able to make a diagnosis from the clinical and the roentgenologic findings. When doubt as to the true nature of the lesion exists biopsy and a roentgenogram of the thorax are indicated. The treatment is surgical and the preferable method is guttering or saucerization of the affected portion of bone with local use of sulfathiazole.

When penicillin becomes generally available and can be administered during the acute stage of the disease it is possible that chronic sclerosing osteitis may be prevented.

REPORT OF CASES

CASE I.—A boy seventeen years of age was seen because of pain and swelling and tenderness in the region of the middle third of the right femur of about one year's duration. The roentgenograms disclosed sclerosing osteitis involving the middle third of the right femur with a small region of decreased density. The blood Wassermann reaction was negative. The sedimentation rate (Westergren's method) was 3 mm in one hour. The concentration of hemoglobin was

11.2 gm per 100 cc of blood erythrocytes numbered 3 660 000 and leukocytes 8 600 in each cubic millimeter of blood Saucerization operation of the sclerotic region disclosed two pockets of granulation tissue The wound was sprinkled

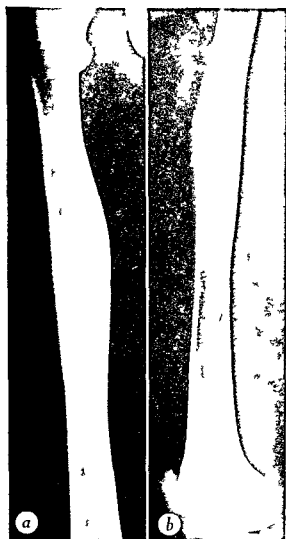


Fig 300—*a* Anteroposterior view showing sclerosing osteitis of middle portion of shaft of right femur with an area of decreased density in the center *b* Lateral view of same

with sulfathiazole crystals The bacteriologic examination did not reveal any growth of organisms and the pathologic examination showed inflammatory tissue The wound healed with primary intention and the patient had complete relief of symptoms in four weeks (Fig 300 *a* and *b*)

CASE II—A girl seventeen years of age was seen because of pain, swelling, local heat and tenderness of the middle third of the right tibia of one year's duration. The roentgenograms of the right tibia disclosed sclerosing osteitis with an area of decreased density of the cortex in the middle third. A saucerization operation disclosed a pocket like region of granulation tissue but no pus. The



Fig. 301—*a* Anteroposterior view showing sclerosing osteitis of the middle third of the right tibia with an area of decreased density. *b* Lateral view shows decreased density lying in the posterior cortex.

bacteriologic examination did not reveal any growth of organisms and the pathologic examination revealed compact bone. Four years later the patient was one of the women's organizations of the armed forces and had complete relief of symptoms (Fig. 301 *a* and *b*).

CASE III—A boy five years of age was seen with swelling and tenderness of the right forearm of two months duration. Roentgenograms had been taken and a biopsy performed after which a diagnosis of sarcoma had been made and amputation had been advised. Subsequent to this the patient was referred to the

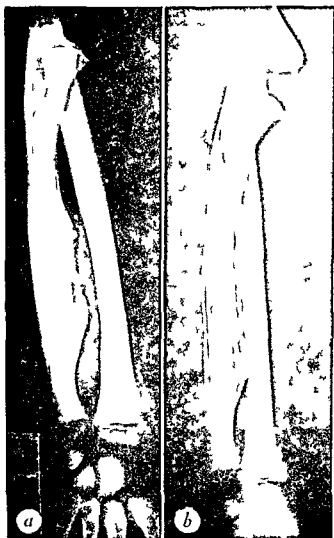


Fig 307—*a* Hereditary syphilis with proliferative periostitis of the shaft of the right ulna. Note that the thickening of the periosteum appears laminated and the shaft of the ulna is visible; these signs would not be present in extensive sclerosing osteitis. *b* Lateral view of same.

Clinic for further advice. The clinical examination revealed hereditary syphilis and this diagnosis was corroborated by a total inhibition Wassermann reaction and by the roentgenograms; the latter demonstrated lamination (onion layer formation) suggestive of hemangioendothelioma (Ewing's sarcoma). The boy's condition improved under treatment (Fig 30 *a* and *b*).

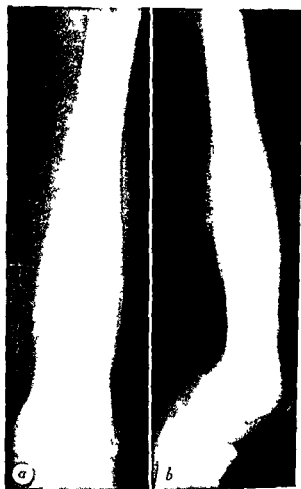


Fig 303—*a* Anteroposterior view showing osteogenic sarcoma of the distal femur with diffuse thickening of the cortex and slight subperiosteal lamination and thickening of soft tissue which was diagnosed roentgenologically as hemangioendothelioma (Ewing's sarcoma). The pathologists' diagnosis on two occasions (from tissue taken for biopsy and from the amputated specimen) was osteogenic sarcoma grade 2 (Broders' method). *b* Lateral view of same.

CASE IV—A boy sixteen years of age was seen because of pain in the left thigh with slight swelling of four months duration. There was no interference with motion of the knee joint and he had been able to ride a horse 5 miles (8 kilometers) to school each day. Examination revealed swelling of the lower half of the left thigh. Leukocytes numbered 15 100 in each cubic millimeter of blood. The flocculation reaction for syphilis and the results of urinalysis were negative. The roentgenologist made a diagnosis of Ewing's sarcoma of the left femur. Biopsy was performed and the pathologist made a diagnosis of osteogenic sarcoma grade 2 (Broders method). Amputation was advised but the patient's father refused to consider it. Roentgen therapy was given on seven occasions during



Fig. 304—Anteroposterior view showing osteitis deformans (Paget's disease) of the pelvic bones and femur. Note the sclerotic appearance of the bones of the pelvis and coarse striations and increased density in the right femur.

the three months following biopsy but without improvement and a high amputation through the thigh was performed by the patient's home physician a year before death. Death apparently as a result of metastasis ensued two years subsequent to the onset of symptoms in spite of all treatment, including amputation. Tissue was sent to us following the amputation and this was again reported as osteogenic sarcoma grade 2 by the pathologist (Dr Broders) (Fig. 303 *a* and *b*).

CASE V—A man fifty years of age was seen with a fourteen year history of gradual enlargement of the head and bowing of the lower extremities. The clinical roentgenologic and pathologic examination revealed osteitis deformans (Paget's disease) (Figs. 304 and 305).

CASE VI—A physician thirty-seven years of age was seen with a hard fixed swelling of the right thigh and previous history of trauma. Operation had been



Fig 305

Fig 306

Fig 305—Anteroposterior view showing outward bowing of the right femur. Same case of ossified hematoma as in Figure 304.

Fig 306—Anteroposterior view showing a large ossified hematoma of the right femur. The shaft of the bone is clearly visible; the new bone formation is laid down parallel to the shaft; the cortex is not thickened; the border is clear cut and there is no involvement of soft tissue.

performed on several occasions during a twenty-one year period. The roentgenologic examination revealed an ossified hematoma of the right femur (Fig 306).

CASE VII—A girl eleven years of age had sustained two fractures of the left tibia which healed with some anterior bowing deformity. She had had occasional sharp pain and some enlargement of the leg had been noticed during the three months prior to her admission here. Examination revealed a bony hard swelling



Fig 307—Osteitis fibrosa cystica of the left tibia with thinning and bulging of the cortical wall trabeculation of the medullary portion and cystic areas containing fine lines or whorls

of the middle third of the left tibia with some local heat and slight tenderness. The roentgenograms showed osteitis fibrosa cystica with thinning and bulging of the cortical wall trabeculation of the medulla and cystic areas containing fine lines or whorls. The diagnosis was corroborated at operation (Fig 307)

CHRONIC NONSPECIFIC TENOSYNOVITIS AND PERITENDINITIS*

PAUL R. LIPSCOMB

DE QUERVAIN a Swiss surgeon in Kocher's clinic at Berne Switzerland reported the first cases of nonspecific tenosynovitis in 1895. The condition which de Quervain described had not been recognized previously. The tendon sheath of the abductor pollicis longus and extensor pollicis brevis tendon which occupy the first groove on the dorsal surface of the radius near the styloid process were affected. Kocher named this condition stenosing fibrous tendovaginitis. It has been referred to as chronic thecitis of the extensor muscles of the thumb and in French literature has been termed at times radial styloiditis. In 1898 Hoffmann^{16, 17} of this country reported twelve cases of what was probably de Quervain's disease and later added fourteen more cases. In 1930 Linkelstein in the most comprehensive of all articles on stenosing tendovaginitis at the radial styloid process reported twenty four cases which brought the total number of reported cases to 178. Since that time the total has been brought to about 250 cases and of these seventy one of the cases on record have been reported in this country.

Compere in 1933 reviewed the literature on snapping thumbs which is the name applied to a lesion affecting the flexor pollicis longus tendon or sheath and is thought by several authors to be similar to stenosing tendovaginitis of the radial styloid process. In two of the forty cases he reviewed the condition was bilateral.

Tenosynovitis of the long head of the biceps also has received limited attention most of which is found in the French literature. Leclercq and Rouresco recognized this condition in connection with injuries of the shoulder sustained in industry. Pasteur a colonel in the medical corps who was stationed in the military hospital Val de Grace recognized the condition in all respects.

ETIOLOGY

It is my opinion that the causative factors in chronic nonspecific tenosynovitis and in peritendinitis regardless of the location are in most cases similar if not identical. In de Quervain's disease it is now pretty well accepted that the inciting factor must be attributed to

Abridgment of a portion of the submitted to the Faculty of the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of Master of Science in Orthopedic Surgery. The author expresses his sincere gratitude to Drs. Ralph K. Ghormley and John R. McDonald for their suggestions in preparation of the thesis.

repeated trauma although in a certain small percentage of cases the onset follows acute trauma. The condition is encountered most frequently in the laboring class and generally among women. Diack and Patterson pointed out that occupations requiring repeated abduction of the thumb under stress or grasping motions combined with adduction of the thumb and ulnar deviation of the wrist for example type writing, knitting, fly casting, golfing, playing the piano, work on grinding or buffing machines and so forth cause this condition. Apparently a heavy type of work is not a necessary factor although many cases are reported among factory workers. Eschle, Cotton, Morrison and Bradford explained de Quervain's disease on a mechanical basis; they stated that the position of the tendons of the abductor pollicis longus and the extensor pollicis brevis causes them to be exposed more than other tendons in the forearm to friction and other minor forms of external trauma. Huber stated that an individual predisposition must be taken for granted.

Snapping fingers also are due in most instances to chronic trauma although as will be shown later in a certain rather high percentage of the cases the pathologic changes are somewhat different from those of chronic nonspecific tenosynovitis. Zelle and Schnepf reported a case in which the condition was precipitated by acute trauma. The hand slipped and the thumb was abducted forcefully. However before this episode the patient had been subjected to continuous prolonged vigorous occupational strain. Compere suggested a congenital basis for involvement of the flexor pollicis longus when a nodule is found on the tendon but as most of the patients in the cases he reported were more than forty years of age this hardly seems reasonable. Hammer stated that tendons of human beings will not tolerate more than 1 500 to 2 000 manipulations per hour.

Conn pointed out that *minor injuries* may eventuate in disease of the tendon sheaths. Ordinarily, however, minor hemorrhages which may result are readily absorbed and only by repeated injury in the same location could this be a factor. Conn further stated that *infections* when present must be accorded a secondary role and are of two classes, exogenic and endogenic. Cohn, however, in 1916 expressed the belief that tenosynovitis is due to irritation from within which he blamed on foci of infection. As a result of the focus of infection he was of the opinion that the part was unable to withstand the irritation from without caused by constant use of the part. He further stated that in all cases of occupational tenosynovitis the focus of infection could be found if sought.

Schrager stated that trauma is by far the most important etiologic factor in tenosynovitis of the long head of the biceps humeri and that the trauma is usually in the form of a sudden jar or pull. He stressed also the relation of infectious disease and stated that sudden muscular

effort in the course of an infectious disease and especially in typhoid or influenza is likely to initiate the syndrome. Infection with colon bacillus occurred in two of Pasteur's cases and with bacillary dysentery in another. The tendon of the long head of the biceps takes part in all the movements and in the fixation of the upper extremity; thus fact explains its vulnerability. Devenish reported two cases of hematoma of the sheaths of the flexor tendons of the hand following penetrating wounds.

Howard^{1, 10} stated the affection called crepitating tenosynovitis, traumatic tenosynovitis and crepitating peritendinitis results in most instances from prolonged exertion of unaccustomed muscular effort. He pointed out that the time over which the forces are exerted is the essential external factor which distinguishes these lesions from the acute trauma of violence. He recognized certain predisposing general factors and the fact that peritendinitis crepitans is frequently the result of gross trauma with a blunt instrument. In about half of the cases studied by Howard trauma was followed by unusual exertion or toil.

MATERIAL STUDIED

An analysis was made of all cases of nonsuppurative tenosynovitis encountered at the Mayo Clinic from 1935 to 1939 inclusive. Records were found of 190 patients who had nonspecific tenosynovitis. In this group were included cases of crepitating, noncrepitating and stenosing tendovaginitis in all locations; cases of the tuberculous and arthritic types of tenosynovitis and tenosynovitis secondary to tumors were excluded.

The average age of this group of patients was thirty-six years. At this age of early middle life physical activity is usually not as great as during the earlier years, but nevertheless an individual is most likely to overexert himself suddenly without realizing his decreasing ability to stand as much physical exercise as formerly.

There were about twice as many females as males in my series of 190 patients. Howard in a study of seventy-two cases of crepitating peritendinitis found that 91.5 per cent of his patients were males and 8.5 per cent females. Winterstein in 1927 stated that stenosing tendovaginitis of de Quervain most frequently affects women of advanced years; the ratio of women to men in his series was approximately 10 to 1. He found in a review of all the accessible cases previously reported plus fourteen of his own, a total of 154 cases that the average age of the patients was fifty-five years. Finkelstein reported twenty-four cases, twenty among women and four among men. The average age of the women was thirty-eight years and of the men thirty-nine years. Finkelstein's numbers nearly approach our figures.

A definite history of trauma was present in ninety-two (48 per cent)

of the Clinic cases. Of these ninety two cases chronic trauma had occurred in slightly over half of the cases and acute trauma in the remainder. A history of infection or an infectious lesion was found in only ten cases (5 per cent) and faulty foot mechanics were thought to account for the same number of cases. The etiologic factor could not be determined in seventy eight cases (41 per cent).

The average duration of symptoms before examination at the Clinic among the 171 patients who were able to recall this fact was eight months. Twenty five patients had had symptoms one year or longer. Of the patients who had had symptoms for less than a year the average duration before treatment was instituted at the Clinic was two months. The period which elapsed between the onset of symptoms and the time the patient was seen is more or less typical not only of these patients but of most others suffering from chronic complaints when seen at the Mayo Clinic.

Of the 190 histories reviewed crepitation was mentioned as being definitely present in only thirty two (17 per cent). It is probable however that crepitation was present in a much higher percentage of cases than this figure indicated.

PATHOLOGY

Comparatively little has been written on the pathology of so called simple tenosynovitis, crepitating tenosynovitis or peritendinitis, crepitans and so forth. Obolenskaja and Goljanitzki in 1927 stated that the characteristic reaction of all synovial membranes to irritation is exudation which in turn leads to a deposition of fibrin in the sheath with resultant crepitation on motion. This observation was borne out in both clinical investigation and experimental investigation with animals. Most observers have reported *primary changes in the tendon sheath* in cases of tenosynovitis and also the presence of a serous exudate.

Hammer stated that in the acute form tenosynovitis is characterized by marked congestion of the walls of the tendon sheath with excessive outpouring of serum and fibrin; the serum later is absorbed and the remaining fibrin glues the layers of the sac together. Troell maintained that the primary pathologic change does not always originate in the sheath but may be in the tendon or in the fibrous compartment formed beneath the annular ligament where tissue granulation or a growth about the tendon may cause symptoms by mechanical means.

Howard¹⁸ stated that in peritendinitis crepitans the primary changes are without doubt in the muscle and furthermore that the disease is not connected with the synovial tendon sheaths and is not synovitis sicca. He maintained that muscle glycogen is depleted and that acute degenerative changes in muscle, thrombosis of venules, retention of lactic acid, edema and local increase in hydrogen ion concentration of

the muscle to relatively high acid reaction also occur. Interstitial deposits of masses and clumps of fibrin are supposed to give rise to the distinct diagnostic clinical sign of crepitation in the involved soft parts. In 1931 Arthur stated that the muscles seemed to be involved more severely than the tendons and that the condition is therefore more a myofascitis than a tenosynovitis. Most authors however do not accept this theory.

Kulowski stated that in tendovaginitis or tenosynovitis the pathologic changes are analogous to those found in chronic bursitis and deforming arthritis and that fibrous cartilage may even develop in the affected tendon sheaths.

The pathology of stenosing tendovaginitis whether it be at the radial styloid (de Quervain's) or about other tendons seems to be essentially the same. Thus Huber stated that a typical finding in the histologic picture is the appearance of fibrocartilage in the inner sheath. Between the fibrocartilage numerous elastic fibers often run in a predominantly circular manner and form more or less thick nets in the inner sheath. He further stated that inflammatory changes which are not present in all cases are found principally in the outer sheath. In two cases he found a form of ganglion in the thickened sheath. In one hemosiderin pigment was present which probably signified traumatic origin.

In seventeen of the forty cases of snapping finger reviewed by Compere the pathologic change was found in the tendon itself rather than in the sheath. In these seventeen cases nodules were found in the flexor pollicis longus tendon with of course the same mechanical result that would be obtained from stenosis of its sheath.

That most recent authors seem pretty well agreed on the pathology of de Quervain's disease probably is due in a large measure to the work of Finkelstein. Prior to his work reports on the pathologic findings revealed rather striking differences of opinion. However on close study of the opinions offered by the earlier writers all of the differences can be correlated if it is realized that their conclusions were based on cases in which the time element is different or in other words there is a different degree of chronicity. Finkelstein stated that in mild cases microscopic changes may be slight the tendon sheath being about twice the normal thickness without visible inflammatory changes. In severe cases the sheath may be three or four times thicker than usual densely fibrous or even cartilaginous. It may be brownish or reddish and may have lost the normal pearly luster. Adhesions may be present. The tendons may be flattened and thinned out and at times may be frayed and covered with granulation tissue. Beyond the point of constriction the tendons may be bulbous.

Finkelstein in his microscopic study described thickening of the synovial membrane which in mild cases is thinned at the point of

constriction. The loose connective tissue layer is considerably thickened and vascularized; the ligamentous layer is slightly thickened but not vascularized. In severe cases he found that the synovial layer is destroyed completely and the loose connective tissue layer is compressed and thinned out, whereas the ligamentous layer is thickened markedly and undergoes hyaline and cartilaginous transformation. He found thickening of the walls of the blood vessels and cellular infiltration of the tissues with numerous lymphocytes. Finkelstein stated that between the mild and severe types there are many gradations.

Finkelstein traumatized the tendons over the paws of sixteen rabbits. The trauma was of thermal, mechanical, chemical and surgical nature.



Fig. 310—Nonspecific tenosynovitis showing irregular layer of synovial cells layer of young lymphocytes and fibroblasts with numerous dilated blood vessels and a layer of older fibrous tissue ($\times 100$)

The animals were examined two to ten weeks later and the lesions from the gross and microscopic standpoint and the changes encountered closely resembled those found in stenosing tendovaginitis of human beings.

In addition to the already mentioned changes Schneider described small irregular necrotic areas in the region of the outer sheath. He stated that occlusion often is produced directly by necrotic masses and that this observation indicates a reaction to trauma or excessive use which is not inflammatory.

As far as I can determine the pathology of tenosynovitis of the long head of the biceps has never been fully described. Schrager stated

that the inflammatory process involves the tendon as well as the bursa. The muscles in and about the shoulder may atrophy but this is probably a secondary phenomenon.

Clinic Series—I was able to examine the pathologic reports in all of the fifteen cases in the Mayo Clinic series in which operation was performed and the tissues and microscopic sections in twelve of these cases. In all fifteen cases the involved sheath of the tendon was thickened greatly and had lost its normal pearly luster. It had a reddish tint in one case. In one case definitely murky fluid was present under pressure. No changes were described in the tendons in any case.



Fig. 311—Non-specific tenosynovitis showing myxomatous degeneration which is practically identical with the picture of central liquefaction seen in adenomatous bursa ($\times 100$).

In some of the cases there was proliferation of the synovial lining with villous formation in others (Fig. 310) yet in the remaining cases the synovial layer was almost or entirely absent and seemed to have been worn away. In all cases studied the fibrous tissue had increased but it was of varying degrees of maturity. The fibroblasts were exceedingly young in three of the cases and had the appearance of endothelial cells. This observation tends to substantiate Robertson's contention that these young cells are endothelial in origin. The vascularity of the tissue varied from slide to slide and seemed to have a definite relationship to the duration of the disease. Myxomatous degeneration which probably represents the central necrotic areas described by Schneider was noted in five cases and in one of these the picture was

practically the same as that of central liquefaction seen in adventitious bursae (Fig 311)

Marked fibrosis and collections of hemosiderin which were suggestive of trauma as the etiologic factor (Fig 312) were noted in one case. In the same case a nerve was encountered about which there was marked fibrosis with scattered collections of lymphocytes. This finding may explain the pain which persists so steadily in cases of tenosynovitis. In only one case could actual cartilage cells be seen although in another the dense connective tissue was hyalinized definitely in time cartilage probably would have developed (Fig 313). In one section studied unorganized fibrin was found within the sheath and young fibroblasts were present in this fibrin (Fig 314).



Fig 312—Nonspecific tenosynovitis showing marked fibrosis with collections of hemosiderin bearing out the traumatic etiology ($\times 155$)

Although the microscopic picture varied slightly from slide to slide it was a rather simple matter to piece together these pictures. The primary change is usually in the tendon sheath if a sheath is present and if not in the peritendinous tissue. Furthermore all types of chronic nonspecific tenosynovitis appear to represent a single disease process in which the pathologic changes vary in degree only and are dependent on the chronicity of the disease and perhaps to a lesser extent on the location and etiologic factors.

In the cases encountered at the Clinic definite pathologic changes were found in the tendon sheaths which were examined. Furthermore definite serous effusion with clumps of fibrin was found in the tendon



Fig. 313—Non-specific tenosynovitis showing a hyalinized layer with numerous chondroblasts, a layer of young connective tissue cells and a layer of older connective tissue ($\times 100$)



Fig. 314—Non-specific tenosynovitis showing fibrin in the beginning region at the site of injury ($\times 100$)

sheaths in some cases in which the clinical sign of crepitation was elicited and also in some cases in which it was not present. If the changes had been in the muscle primarily it would have been impos-

sible for the fluid to gravitate into the sheath except perhaps through the fibers of the tendons themselves. Inasmuch as the tendons were normal in all instances this seems highly improbable. Of the cases of tenosynovitis in which I have elicited crepitation it has always seemed maximal over the tendon itself although it has involved the muscles in some instances. Although perhaps in some cases the muscles may be involved in conjunction or secondary to the sheath I doubt that the changes are primary there. It seems only logical to assume that synovial tissue which is subjected to chronic trauma in uncushioned and relatively unprotected places will react to irritation much more quickly and to a greater degree than will muscular tissue which usually is



Fig 315—Nonspecific tenosynovitis probably on infectious basis. The marked cellular increase of lymphocytes and the decrease of fibrous tissue should be noted ($\times 100$)

located more favorably. This is especially true since it usually is accepted that muscle is of different origin and therefore is not so quickly responsive to irritation.

In cases in which infection may have played some part in causing the condition the microscopic picture of the tendon sheaths often resembled that seen in chronic infectious arthritis. Thus in one case in which the right tibialis anticus sheath had been involved for two or three years no history of trauma could be obtained (Fig 315). However at the time the patient was seen at the Clinic she was also suffering from periarticular arthritis of the elbow. The sedimentation rate of erythrocytes in this case was only 23 mm at the end of one hour.

(Westergren method) It did not seem correct however to classify this as a case of arthritic tenosynovitis in spite of the fact that the microscopic picture did resemble that seen in arthritic tenosynovitis. It is possible and even probable that the marked cellular increase and especially the lymphocytes seen in this case and to a lesser degree in others were dependent on an infectious etiology. Although lymphocytes were predominant in the microscopic section (Fig. 315) plasma cells were also present. Figure 315 should be compared with the fibrosis, liquefaction, necrosis and hyalinization seen in most of the cases of definite traumatic origin.

SYMPTOMS

The most common symptom of any kind of tenosynovitis is pain over the tendon or tendons involved which is greatly exaggerated on motion of the tendon. At times the pain is of a neuralgic character. It usually extends along the entire course of the tendon and the belly of the muscle. Colin pointed out that usually all tendons lying in the same synovial compartment are involved simultaneously. For this reason it is often difficult to localize the pathologic change. In the more acute stages increased local heat, redness and swelling of the overlying skin usually are present. Wood pointed out that in de Quervain's disease prominence of the tendons of the abductor pollicis longus and extensor pollicis brevis is absent or diminished in the lateral border of the anatomic snuff box during active extension. There is usually an associated weakness of the extremity as a result of the pain. Crepitation may or may not be present in any type of tenosynovitis and is by no means constantly present even in so called crepitant tendovaginitis.

In *stenosing tenosynovitis* other than that at the radial styloid the so called snapping finger usually is present. This is due to either narrowing of the sheath or enlargement of the tendon which prevents free passage of the latter. The obstruction is usually passed with a click or snap. This snapping is not necessarily present in de Quervain's disease at the radial styloid but when the flexor tendons of the hand are involved by stenosing tendovaginitis the snap is almost always present.

In *de Quervain's disease* the chief complaint is pain about the styloid process with extension up the forearm and into the thumb. The patient is often disabled and may complain of dropping articles because of pain or insecure grip. The most painful motion is extreme adduction of the wrist and the other painful motion is extreme abduction of the thumb. If the patient grasps the flexed thumb with the remaining four fingers and quickly abducts the hand ulnarward the pain over the styloid tip is excruciating. This is probably the most pathognomonic objective sign of de Quervain's disease. Crepitation

TABLE 1—LOCATIONS OF INVOLVEMENT OR TENDON INVOLVED IN 190 CASES

Side	Location or Tendon Involved	Cases	Side	Location or Tendon Involved	Cases
Both	Wrists	7	R	Long head of biceps	7
R	Wrist hand or fingers (unable to separate further)	17	L	Long head of biceps	4
			L	Brachioradialis	1
L	Wrist hand or fingers (unable to separate further)	4	Both	Ankles	1
			R	Foot or ankle	8
R	Wrist or hand (extensors)	13	I	Foot or ankle	8
L	Wrist or hand (extensors)	3	R	Anterior tibialis	13
R	Flexor carpi radialis	4	L	Posterior tibialis	5
R	Flexor carpi ulnaris	2	R	Peroneals	4
L	Flexor carpi ulnaris	3	L	Peroneals	4
R	Flexor pollicis longus	8	L	Anterior tibialis	9
L	Flexor pollicis longus	3	R	Posterior tibialis	7
R	Extensor pollicis brevis and abductor pollicis longus	9	R	Tendo achillis	6
			I	Tendo achillis	8
L	Extensor pollicis brevis and abductor pollicis longus	1	R	Extensor hallucis longus	1
			L	Extensor hallucis longus	5
R	Flexor of second (or index)	3	R	Flexor hallucis longus	1
R	Extensor of the third finger	1	L	Flexor hallucis longus	2
L	Extensor of the third finger	1	L	Biceps femoris	1
R	Flexor of the third finger	2	R	Bicep femoris	1
L	Flexor of the third finger	3	L	Adductors of thigh at inguinal region	1
R	Extensor of fourth finger	1			
I	Extensor of fourth finger	1		Ankles and wrists	2
R	Flexor of fourth finger	2			
I	Flexor of fourth finger	2			
I	Extensor of fifth finger	1			

One of the patients with tendovaginitis had bilateral involvement

usually is not present but it may be. A circumscribed thickening of the tendon sheath may be felt on palpation and often a cartilaginous thickening is felt over the styloid process. Roentgenologic examinations almost uniformly reveal nothing abnormal.

The pathognomonic symptom and sign for *tenosynovitis of the long head of the biceps* as Schrager pointed out is subjective pain and tenderness along the bicipital groove.

The other forms and types of tenosynovitis have no particularly distinguishing features except perhaps by the location involved.

In our series of 190 cases the location of the involved sheaths is given in Table 1.

DIFFERENTIAL DIAGNOSIS

It is most important to distinguish simple forms of tenosynovitis from *tuberculous tenosynovitis*. In tuberculous tenosynovitis usually marked swelling with considerable bulging above and below the annular ligament gives the so called hourglass appearance. It may be possible too to detect rice bodies by palpation. Tuberculous tendovaginitis is less often primary than secondary; it usually occurs by extension from a focus of infection in a bone or joint. Aspiration of the fluid and animal inoculation may be necessary before the diagnosis can be established in doubtful cases. In some instances too it may be necessary to distinguish tuberculous osteitis from stenosing tenosynovitis at the radial styloid process. Negative roentgenologic findings nullify a diagnosis of tuberculous osteitis.

Finkelstein stated that stenosing tendovaginitis at the radial styloid process can be differentiated from *tendovaginitis crepitans* by the absence of friction during movements of the thumb but most authors do not agree as crepitation may be present in stenosing tendovaginitis.

Neuritis may be ruled out by negative neurologic findings and the absence of hyperesthesia.

The constancy and uniformity of the complaint and the failure of antirheumatic therapy speak against *rheumatic diseases*.

Negative history, blood and roentgenologic examinations aid in excluding *gout*, *gonorrhea* and *syphilis*.

Nonspecific tenosynovitis must also be distinguished from hypertrophic arthritis, fractures or sprains of the wrists, ganglion and bursitis, traumatic myositis, aseptic necrosis, cysts of the carpal bones, interstitial calcinosis and senile processes arising from joint capsules.

In cases of tenosynovitis of the long head of the biceps the character of the preceding trauma is usually in the nature of a jar or a sudden pull on the tendon rather than a single violent blow on either the shoulder or tendon. Topographical pain along the bicipital groove is a pathognomonic sign in this ailment.

Occasionally a *hematoma of a tendon sheath* caused by a penetrat

ing wound may mimic acute suppurative tenosynovitis. In the former the temperature and pulse rate usually are not increased.

Devenish stated that in case of hematoma of the tendon sheaths following penetrating wounds other features are (1) pain swelling and loss of function in the distribution of the sheaths (2) appearance of delayed bruising where the sheaths are near the surface depending on the posture of the patient and (3) rapid recovery.

TREATMENT

The treatment of all types of tenosynovitis resolves itself into non surgical and surgical. It would be a mistake to call surgical treatment radical for it seems to have been proved rather definitely that in certain cases of tenosynovitis this is the most conservative form of treatment. Although many and varied types of nonoperative treatment have been recommended careful analysis indicates that the primary one recommended is splinting of the part by various means.

For simple or crepitating tenosynovitis or peritendinitis all treatment advocated is nonoperative and all writers advise one form or another of immobilization. In addition to a detailed description of a type of immobilization Gould advised appropriate medical treatment if a toxic factor is discovered. This of course would consist primarily of eradication of all foci of infection and possibly administration of such drugs as sodium salicylate potassium iodide or colchicine as indicated.

Cohen and Reid reported seven cases of tenosynovitis of the wrist. In all of these cases adequate response to treatment had not occurred until measures were employed to combat the associated oxaluria. In two of these cases renal calculi had been present. Following treatment for oxaluria the tenosynovitis in all seven cases cleared up completely in three to eighteen weeks although the tenosynovitis had been treated for months prior to this in most cases. Treatment of the oxaluria consisted of dietetic instructions to the patient to avoid all those foods which were rich in oxalic acid to drink a great deal of water daily and to take a teaspoonful of citrate of magnesia each day. The last was probably given in an attempt to alkalize the urine as calcium oxalate crystals are found in acid urine. In addition these authors advocated firm and absolute immobilization applications of radiant heat musoidal current and diathermy which seemed to relieve the pain. The patients were advised to adhere to the diet for an indeterminate length of time in order to avoid recurrence.

Fieldman stated that rest counterirritation radiation and splints are the accepted forms of therapy but that relief from these agents is often only slightly more lasting than the duration of their application. He advised Unna's paste boot and gave detailed instructions concerning its application.

Roentgen therapy also is widely advocated in the treatment of simple tenosynovitis or tendovaginitis crepitans. Herrnheiser especially recommended roentgen therapy in small doses for the more acute phases. Oftentimes he used no fixation and cited as advantages this and the fact that a cure is effected in the same or possibly shorter time than with the usual fixation treatment. The patient was often allowed by Herrnheiser to work moderately with the injured extremity during the period of treatment.

Howard^{18, 19} stated that adequate complete immobilization of joints and portions of the extremity moved by the affected muscles and tendons is the logical and most effective treatment. For this immobilization he advocated molded plaster of paris splints lightly reinforced by circular plaster. If the lesion involves the abductor pollicis longus and extensor pollicis brevis either together or in connection with the two radial carpal extensors the thumb should be included in the cast in a comfortable position of function. Howard said: Surely massage, baking and diathermy have no place in the treatment of tenosynovitis. He analyzed thirty-four cases in which treatment consisted of complete plaster immobilization and found that the average disability was 11.6 days and an observation period of 16.8 days as compared with 22.6 days and 27.3 days respectively in cases in which board splints were used and the thumb was occasionally left free. In cases in both groups in which inadequate immobilization or too short recovery periods of splint rest were followed by diathermy, baking, massage and strapping the average disability period was 45.1 days.

Devenish advised the patient to use a sling for a few days in case of hematoma of the flexor tendon sheaths of the hand.

Keyes, Burns and Ellis, Dieck and Trommald and most other writers advocated the operation of de Quervain as the treatment of choice in *stenosing tendovaginitis at the radial styloid process*. As described Howard used simple immobilization in the six cases he treated and each patient continued his occupation. The longest course of treatment was two months. During the acute stage Finkelstein advocated conservative treatment which consists of immobilization in a plaster cast, compression bandage or splint, baking, massage, diathermy and counterirritants in the form of vesicants applied over the swelling and potassium iodide internally. If relief is not obtained within a period of four weeks operative treatment is indicated.

Most authors report cure with the conservative measures of treatment in about 70 per cent of cases of tenosynovitis at the radial styloid process whereas immediate cures are reported after operative treatment in practically 100 per cent of cases.

In cases of stenosing tenosynovitis in other locations usually manifested by the so called snapping finger, observers have reported an eventful recovery following operation.

In cases of tenosynovitis involving the long head of the biceps Schrager stated that much benefit and occasionally instant cure can be obtained by sudden traction on the arm and shoulder while the arm is relaxed and in a position of abduction based on the supposition that the tendon is replaced in an improperly fitting groove. In the acute phases the patient must rest in bed placing the arm and forearm in two pillows to get some comfort. All types of local application of heat are usually beneficial but diathermy is the principal remedy especially in the acute cases. In subacute and chronic cases massage and exercises to increase the range of motion are added to the regimen. Potassium iodide has been suggested in chronic cases.

Clinic Series.—The treatment used and the results in the Clinic series is given in Table 2. Of the fifteen patients who underwent operations

TABLE 2—TREATMENT AND RESULTS IN 190 CASES

	R ^g Th ^{py}		Phy ^{cal} Th ^{py}		R ^g Th ^{py}		Phy ^{cal} Th ^{py}		Spl ^{ts}		C ^{mb} f ^{Sp} l ^{ts} and R ^g Th ^{py}		Of ^t	
	C	P ^t	C	P ^t	C	P ^t	C	P ^t	C	P ^t	Case	P ^t	C	P ^t
C ^{mpl} t ^r l ^f	41	66	16	28	7	39	2	14	13	54	9	60		
P ^t l ^f l ^f	3	5	6	10	6	13	2	14	2	8	2	13		
N ^l f	5	8	10	18	2	11	3	22	3	13	1	7		
N ^l l ^w p	13	21	25	44	3	17	7	50	6	25	3	20		
T ^l l ^{es}	62		57		18		14		24		15			
I ^t p ^t w ^{pe} f ^{med}														

two suffered from conditions involving the flexor tendon of the thumb. Follow up data were inadequate in these cases. The extensor tendon of a finger or fingers other than the thumb was involved in four cases. In three of these complete relief was obtained and in one the follow up data were inadequate. In one case the flexor tendon of the middle finger was involved after operation much relief was obtained although some snapping was present eight months later. In one case in which the flexor tendon of the index finger was involved only partial relief was obtained by surgery. In another in which the flexor carpi radialis was involved complete relief followed operation. In three of the four cases in which a tendon of the foot or ankle was involved complete relief followed operation whereas in one case no improvement resulted.

Sixteen of the 190 cases of nonspecific tenosynovitis were of the de Quervain's type (stenosing tendovaginitis at the radial styloid). Operations were performed in only two cases of this group. Complete

relief was obtained in one partial relief of symptoms in the other. Exploration was advised in one case but the patient refused the operation. The remaining thirteen patients were treated by conservative methods. Three of these recovered in a few weeks and four others were improved but not cured. Follow-up data on five patients were incomplete while one received no relief from conservative measures.

Judging from the results in the Clinic series of cases roentgen therapy preferably with splinting is the treatment of choice in the first place. If after two months of such treatment combined with physical therapy during the second month the tenosynovitis is not improved operative procedures seem justified. Surgical treatment consisted of incision or excision of the sheath whichever was indicated. Complete relief should not be promised from surgical treatment.

SUMMARY AND CONCLUSIONS

As a result of a study of 190 cases of chronic nonspecific tenosynovitis it is believed that this condition is usually caused by trauma and is essentially the same regardless of the location. The various pathologic changes differ only in degree and depend primarily on the duration of the disease. In those few cases in which the condition is *probably due to infection* the pathologic changes are different from those caused by trauma.

Treatment should be conservative for two months; then if improvement has not occurred surgical procedures are indicated. Either incision or excision of the sheath whichever is indicated offers the best chance of cure. Roentgen therapy combined with splinting is the conservative method of treatment that offers the best results.

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PLASMA AND BLOOD IN TREATMENT OF SHOCK FROM BURNS

JOHN S LUNDY R CHARLES ADAMS AND THOMAS H SELDON

IN CASES of burns the anesthetist may be called upon to render what might be called first aid or preliminary treatment before the surgeon can treat the burns themselves. This paper is a discussion from the standpoint of the anesthetist of the problems of supporting the patient. The sudden onset and intensity of shock due to a burn or burns depend on the extensiveness and on the degree of the burn.

SEDATIVES

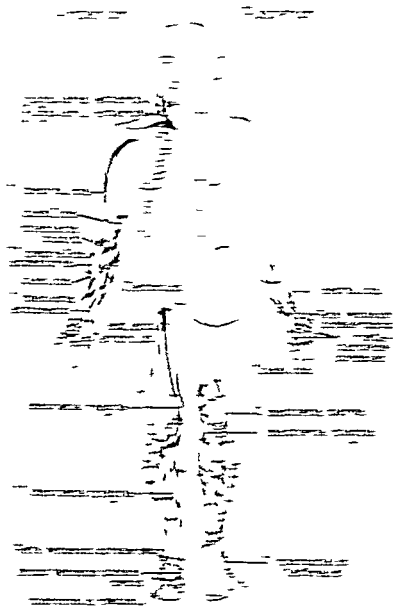
One of the first symptoms indicating that the burn is serious is the pain suffered by the patient. Morphine sulfate is the usual drug employed for the relief of this pain and the doses of morphine employed sometimes need to be large. When the area of skin involved is large it may be difficult to give morphine intravenously and in such case it should be given intramuscularly so that it may produce its effect quickly. If enough veins are left in unburned areas so that one may use them for the administration of morphine the intravenous method of giving morphine produces the quickest relief and is the most accurate method of determining dose. The reactions to the morphine are evidenced by a relief of pain and by a contraction of the pupil. Most persons suffering pain will tolerate morphine in a large dose and until the pupil is nearly pin point. For most adults one may administer $\frac{1}{4}$ grain (0.016 gm) of morphine to begin with followed by another $\frac{1}{4}$ grain of morphine in ten or fifteen minutes. Subsequent doses administered may be smaller than $\frac{1}{4}$ grain depending upon the size of the patient and what relief he already has experienced from the first dose or two.

When the patient has arrived at the hospital or at a point where he is to be given more treatment than a simple dressing in an attempt to relieve his pain it usually is advisable to search for a good sized superficial vein into which a stiletted 15 or 18 gauge needle can be inserted. Through this needle one should be able to administer pentothal sodium solution intravenously as an anesthetic agent and at the same time to administer plasma crystalloid solutions blood or what ever may be available or necessary. If a metal Y connector is not available so that the pentothal sodium and supportive fluid can be administered simultaneously one may make a substitution by inserting a needle through the side wall of the tubing.

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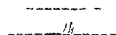
VENIPUNCTURE

STEP I

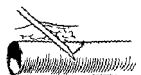


STEP II

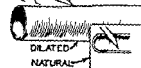
TOP VIEW

SKIN WHEEL MOVED
LATERALLY

LATERAL VIEW

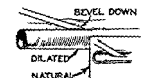


BEVEL UP

DILATED
NATURAL

STEP III

LARGE VEIN



BEVEL DOWN

SMALL VEIN

DILATED
NATURAL

Fig 317—Technique of venipuncture. Step I. A 1% procaine hydrochloride solution is used. For the majority of adult patients this step is unnecessary. Step II. The needle is thrust through the skin. An attempt should not be made to enter the vein the first time; rather the skin wheal is moved laterally. Then the skin should be moved back so that the needle lies against the side of the vein. Step III. The skin is no longer pinched. The needle enters the vein. With the bevel up in place the vein is dilated. If the vein is large the point of the needle will be entirely within the lumen. When the vein is not dilated, on the other hand, the vein is very small; the point of the needle will not be far from the lumen of the vein when the vein is not dilated unless the needle is held at the bevel down.

It is important to produce mild negative pressure in the syringe as soon as the point of the needle has been thrust into the skin. Also a counter pull must be exerted on the vein with the hand that does not hold the syringe. If the anesthetist is right handed the syringe is held in the right hand and the needle is inserted through the skin. The fingers of the right hand grasp the plunger and the up of the right thumb is placed against the edge of the barrel to produce

possible to enter the arterial system, as in extreme cases but for the most part one is now able to introduce fluids into the venous system in nearly all cases.

Figure 16 shows a great many superficial veins and it usually is possible to find at least one or two of them that are still covered with unburned skin. Under more serious circumstances a vein that is in the

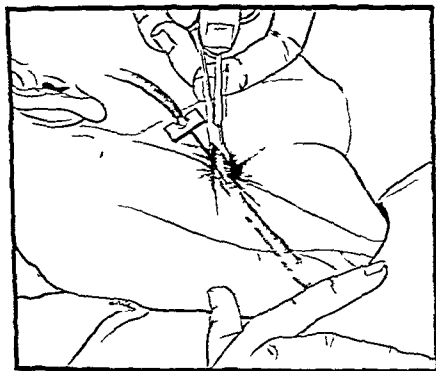


Fig. 16.—Venipuncture of the external jugular vein.

radius of a burned area may be used, although that is not desirable. The technique for venipuncture is illustrated in Figure 17. Figure 18 shows a technique for venipuncture of the external jugular vein and Figure 19 shows a technique for venipuncture of the internal jugular vein.

the negative pressure. The fingers of the left hand are pressed against the skin overlying the vein at a point far enough from the skin which the needle enters the skin so that the left hand does not move in any way with bending the needle and moving back with the puncturing skin. Unless counter-pull is exerted with the left hand, venipuncture may become very difficult, especially in veins around the wrist and in the hand, because the veins are movable and must be fixed if they are to be entered easily by the needle. The direction of the counter-pull must be exactly opposite to the direction in which the needle is inserted. (Lancet, Ann. J. Surg., Vol. 4)

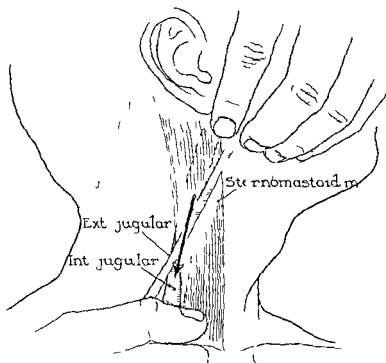


Fig 31) Site of en punctu e in int rnal jug l r ve n

INTRAMARROW INJECTIONS

If the onset of shock is delayed until about the time when pentothal sodium is administered the pentothal sodium tends to dilate the peripheral veins and is sometimes helpful in that way. There are however many cases in which persons are desperately burned and support is needed immediately so that sometimes it is necessary to insert a needle into the marrow of the sternum (Fig 320). Often children are burned and it may be that one tibia or the other seems to be more readily available than the sternum (Fig 371). When these routes are used certain difficulties are encountered. Usually these are associated with a prolonged retention of the needle in situ in the sternum or tibia. Unless the skin over and in the neighborhood of the sternum is unburned it is difficult to support the needle. Movements of the attached rubber tubing are transferred to the needle. In the course of a day or two the needle has made a hole in the sternum much larger than the needle itself and then the fluids begin to escape from the bone and are not absorbed since they are not confined to the marrow of the bone. In cases in which a needle is introduced into the tibia of a child it often is difficult to keep the patient quiet and in care of him the leg

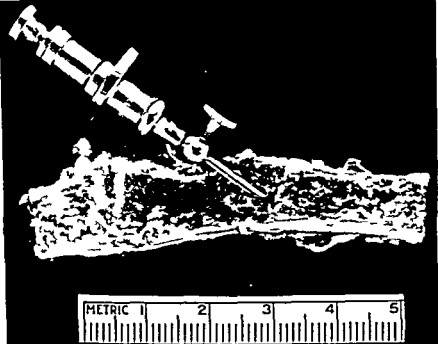


Fig 370—Sternal needle

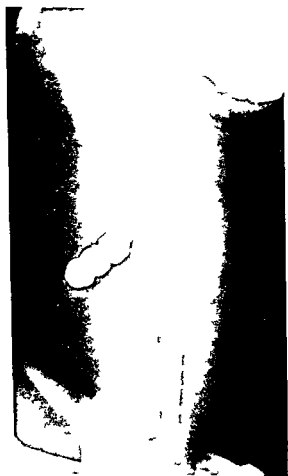


Fig 371—Needle in tibia

is moved frequently and the stilet is taken out and introduced at frequent intervals. Under such circumstances the hazard of osteomyelitis cannot be overlooked so that care must be exercised to keep the needle and stilet as clean as possible and to minimize trauma due to movement of the needle.⁷

CHOICE OF SUPPORTIVE MEASURES AND ESTIMATION OF DOSAGES

After one has overcome the technical difficulties involved in entering the venous system the choice of supportive measures is the next thing to be considered. If the patient has been injured in such a way

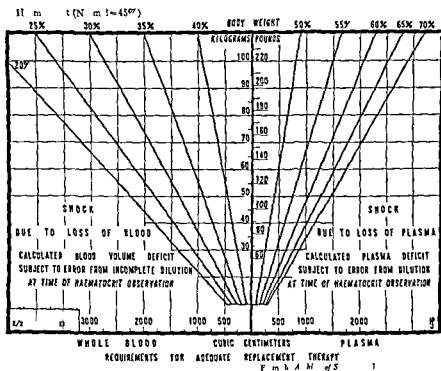


Fig 3 2—Requirements for adequate replacement therapy. To determine requirements for replacement of blood or plasma follow the diagonal line of the haematocrit reading to the point where it intersects the horizontal line of the patient's body weight in either kilograms or pounds then follow the vertical line down to the calibration of the required amount of blood or plasma on the bottom line of the chart (From Jenkins, Schaffner, and O'Neil).

In addition to his burns that he has lost a noticeable quantity of blood one may try to obtain a sample of blood and test it by the copper sulfate method for measuring specific gravities as recommended by Phillips and his associates. By using the tables supplied one can estimate the amount of blood or plasma that seems to be indicated at the

moment Figure 322 is a nomogram⁵ by means of which given the hematocrit reading and the weight of the patient the amount of whole blood or plasma required may be determined Figure 323 gives a suggested method of estimating the percentage of surface involved in a burn and on this basis the amount of plasma needed⁸

The methods illustrated in Figures 322 and 323 are aids in attempting to make quick and accurate estimates of the amount of blood or plasma needed However most patients who are burned are treated

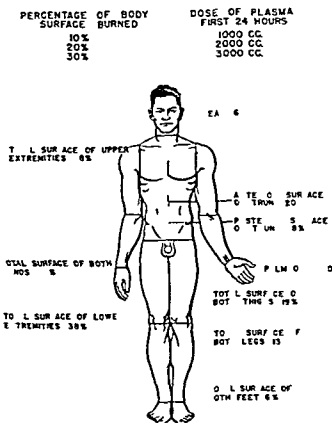


Fig 33—The adjustment of dose of plasma in treatment of burns according to percentage of body surface burned (modified from Berkow) (From Newhouser and Lozner)

where these aids are not available and one must estimate arbitrarily to some approximate figure what one thinks should be done It is difficult to decide the color of the skin of an extensively burned patient and the degree of shock usually is considerable in a case of extensive burn especially if an hour or more has elapsed from the time a patient is burned until he is observed It seems reasonable that, if blood has been lost, at least 500 cc of blood should first be given to the patient Following this plasma in normal concentration should be ad

ministered. The quantity required can be judged from the symptoms and physical findings of the patient that is the pulse blood pressure and breathing will tend to approach normal as one approaches the point where the necessary quantity of fluids has been used and his pain has been relieved. In cases in which blood has not been lost and only the burn has to be treated administration of blood is not necessary. As a matter of fact hemoconcentration usually is already present and administration of blood may be undesirable.³

Plasma in considerable quantity usually is required if the burn is extensive because the patient continues to lose pure plasma from every bit of burned surface. The amount of plasma that is lost therefore may be very great. The surgeon's treatment of the burned surface is partly designed to prevent the loss of plasma. However there is no better supportive treatment for the patient in shock than the administration of plasma. Some years ago before plasma was readily available it was realized that in cases of burns much salt was lost. Accordingly the administration of isotonic saline solution was tried and much benefit resulted.¹ The hemoconcentration was somewhat relieved and the salt content of circulating blood was somewhat restored. The good results of this procedure tended to focus attention on the problem of the mechanism of shock due to burns. Unfortunately however the replacement of fluid and salt was not as effective as it had been found to be in combating the effects of excessive heat among workmen who were benefited greatly by drinking water with salt in it. The loss of plasma from the patient's body can be made up quickly only by the introduction of plasma into the circulation. The dramatic results that have been obtained by administration of plasma in many cases of burns are sufficient evidence that this is a fact. On the other hand it does not necessarily follow that all burned patients who are treated with plasma will survive there have been many who have not survived.

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whole of modern surgical supportive therapy is on a prophylactic basis. This and the competent use of modern anesthetic agents and methods have made it possible to perform successfully long and complicated major operations on patients who originally may have constituted poor anesthetic and surgical risks.

The anesthetist begins before the time of the operation to evaluate the surgical patient and what will happen to him during surgical intervention. From the patient's history he obtains the fundamental facts which may affect the surgical and anesthetic risk. These include the patient's blood pressure, the concentration of hemoglobin in his blood, his past illnesses and operations, the results of urinalysis and blood chemical studies, the degree of cardiovascular sufficiency or insufficiency, estimations of renal and hepatic function, the vital capacity and other respiratory data, and general data such as the patient's emotional tone, the presence or absence of debility and so forth. From the surgeon or his assistants the anesthetist obtains additional information toward completion of his picture. This information has to do with the probable duration of the operation, its extent, and complicating factors peculiar to the particular case.

Having the general condition of the patient in his mind, together with the operative possibilities, the anesthetist chooses his anesthetic or a combination of them, to suit the case. Sometimes it may be best to divide the burden of anesthesia between two or more methods (balanced anesthesia) such as local or regional anesthesia supplemented by intravenous administration of pentothal sodium. The choice of an unsuitable anesthetic agent or improper administration of any anesthetic agent may greatly contribute to the initiation of shock on the operating table. The attempt must be made to administer the minimal amount of anesthetic agent that is commensurate with the needs of the surgeon. A so-called good anesthetic may not necessarily be one which provides optimal working conditions for the surgeon. Too much anesthetization may instigate and also aggravate shock from other causes. On the other hand, too little anesthetization, or the choice of an inadequate agent or method, in the hope of minimizing anesthetic shock may work in the reverse manner. Too light surgical anesthesia, poor relaxation, active reflexes, straining and so forth may lead to prolongation of the operation, excessive retraction and manipulation and excessive surgical trauma in general, all of which contribute to production of surgical shock. It is better in the long run to use a method of anesthesia which is adequate for the operative procedure so that the operation may be expedited and the patient returned to his bed as soon as possible.

We cannot go further into the factors influencing the final choice of anesthesia here. However, if the patient obviously constitutes a poor risk, because of pathologic conditions already present, or because

of the site nature duration and magnitude of the operation certain phases of the anesthetic management must be anticipated in order to minimize shock

The main causative factors which may throw the surgical patient into a state of shock are (1) psychic trauma (2) pain (3) loss of heat (4) surgical trauma (5) oxygen want and (6) loss of blood and other fluid The first two of these are taken care of by the preliminary medication and the anesthetic itself Loss of heat can be minimized by application of external heat and minimal exposure of the region of operation Surgical trauma to a certain degree is inevitable but can be minimized by gentle manipulation by the surgeon and his assistants

Oxygen want however cannot be passed over so quickly Anoxia is a cause of and usually accompanies shock Therefore anoxia and the associated circulatory insufficiency are parts of the vicious cycle of shock Since oxygenation of the patient has to do with aggravating or minimizing shock management of this phase of the anesthesia is important it is the direct responsibility of the anesthetist A continuously patent airway is essential and is best provided by insertion of an intratracheal tube This permits the efficient oxygenation of the patient which is so vital in combating shock It also facilitates artificial respiration and resuscitation if the need arises Apparatus must be at hand for the administration of oxygen under positive pressure whereby the lungs can be inflated should circulatory and respiratory function become depressed Facilities for suction aspiration of the tracheobronchial tree must be provided Collections of mucus blood pus and so forth may lead to obstruction of the lower part of the respiratory tract pulmonary collapse and atelectasis all of which favor anoxia and increase the severity of shock

Considerable consideration must be given to loss of fluid Loss of blood and other fluid is inevitable during the course of an operation and the amount lost depends on a number of factors Insensible loss of fluid and salt from the skin of a patient during the course of an hour on the operating table may approximate 1 000 cc and in longer and very extensive operations may be double or triple this quantity Loss of blood and tissue fluid from the site of operation is variable and may depend on many factors The important thing is that these losses if extensive must be compensated for before the patient reaches a profound state of shock There is no way of substituting for blood and other fluid lost by a surgical patient except by the administration of blood or a blood substitute When loss of blood and other fluid is minimal replacement need not be made until the patient is back in his room

The aim in modern surgical supportive therapy is to anticipate the losses that have been mentioned before they have been sustained and to institute supportive therapy early or at least to compensate for

the losses as they do occur. By so doing it is possible to prevent profound shock even when patients constitute poor risks or bleed profusely during operation. A well organized plan for supportive therapy must be set up and facilities for administration of blood and other fluid must be provided. If intravenous infusion is delayed until shock is well established the veins may be collapsed, venipuncture may be mechanically difficult as has been said and the delay at such a critical time might cost the patient his life especially if massive hemorrhage is occurring.

Complicated apparatus and blood chemical and physical estimations while interesting and enlightening are not essential to the gathering of information relative to the onset of shock. One of us (Lundy) has reiterated that a patient who is pink, warm and dry during the course of an operation probably is in reasonably good general condition. This simple information tells the anesthetist that the patient is well oxygenated that his circulation is adequate and that insensible loss of fluid is at least minimal. This is in contradistinction to a patient who is blue or gray, cold and wet, the typical picture of shock. In addition to knowledge of the rate and character of the patient's pulse, his blood pressure, the capillary filling time (blanching test) and the condition of the skin the anesthetist should have an approximate idea of loss of blood from the field of operation at all times. This when added to the estimated insensible loss of fluid and salt forms a basis for estimating the quantity of fluid necessary for replacement.

Although persistent fall in blood pressure during an operation may forecast the onset of shock, the blood pressure alone is not a reliable sign of the presence or absence of shock. If the fall in blood pressure is not accompanied by a rising pulse rate, if the patient is warm and dry and if it is obvious that there has been little loss of blood or other fluid, no need for alarm exists for the blood pressure probably will return to normal. In such instances however use of stimulant drugs such as ephedrine or neosynephrin may be indicated. On the other hand if the fall in blood pressure is progressive and persistent, if it is accompanied by a pulse that is increasing in rate and decreasing in volume, if the patient's skin is cool and moist and if he obviously has been losing blood, shock has set in and probably will be progressive if left untreated. In such an instance the elevation in blood pressure resulting from administration of stimulant drugs will be transient and will lead only to a false sense of security. The use of stimulant drugs under these circumstances is permissible only as an interim measure to sustain the blood pressure until intravenous supportive measures can be instituted. The important thing when a patient shows this combination of symptoms is to start administration of blood or other fluids or both without delay. When it is obvious that a patient is losing blood and will probably lose more, supportive measures should be be-

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gun at once whether or not signs of approaching shock have begun to appear

For these reasons if an extensive major operation is to be done or if the patient constitutes a poor risk for any reason or if the operation probably will be long and more than the usual amount of blood will be lost the patient is prepared for administration of supportive therapy at the time the anesthesia is begun. This is accomplished by the insertion of a 15 gage Lewisohn needle with stylet in place into a vein in the ankle or arm and strapping it in with adhesive tape. Through this blood or other fluids can be administered at any time. It may be preferable to begin the slow infusion of saline solution or of glucose saline solution through the 15 gage needle at once. When the operation is of particular magnitude two infusions sometimes are begun simultaneously.

Patients' lives may be saved by such preparations if sudden uncontrollable bleeding should occur on the operating table. The size of the intravenous needle is important since cold blood does not run rapidly enough through an 18 gage needle to compensate for acute loss of blood. When replacement of blood must be still more rapid a device for pumping blood in under positive pressure may be useful or a hand roller can be applied to the infusion tubing. The preparations just cited if made before the beginning of the operation furnish means for a degree of control over shock which cannot be duplicated. In addition to preventing delay in instituting shock therapy due to difficulties of venipuncture if the veins are collapsed it obviates confusion about the operating table during times of stress. If these preliminary steps prove unnecessary no harm has been done since few surgical patients fail to be benefited by infusion of a few hundred cubic centimeters of saline solution or of glucose saline solution.

The type of solution necessary in the treatment of shock will vary under different circumstances as will the amount. If the symptoms of shock appear even though when the operation was begun the patient's hemoglobin was of satisfactory concentration and if obviously he has lost little blood electrolytes such as physiologic saline solution or glucose 5 per cent in physiologic saline solution may be sufficient to alleviate the signs of shock. If the patient's hemoglobin was low to begin with whether or not loss of blood was obvious in the course of the operation administration of whole blood or if blood is not available plasma is indicated. The amount required will be estimated on the basis of the amount of blood or other fluid lost. The rate at which the infusion can be given will depend on the rapidity of the loss.

If the loss has been acute and rapid and the blood pressure is well down there is no harm in infusing blood and other fluids as rapidly as possible until the symptoms are relieved and the blood pressure approximates normal. After this desirable effect has been attained slow

infusion is essential to prevent overloading the circulation and preventing such effects as pulmonary edema

The anesthetist has been aided in lessening the risk to and improving the outlook of the present day surgical patient by many innovations. These include the blood bank which permits storage of ample quantities of refrigerated plasma or group O blood; the fact that if necessary cold blood can be given directly to the patient; equipment which permits a rapid change from administration of blood to administration of plasma or of the blood substitutes; modern anesthetic and resuscitation equipment; and finally the centralization under the department of anesthesia in one place and under the responsibility of one person all this life saving equipment together with the responsibility for its use wherever and whenever needed.

POWDERED ERYTHROCYTES FOR DRESSINGS OF WOUNDS AND ULCERS

THOMAS H SELDON JOHN S LUNDY AND R CHARLES ADAMS

FOLLOWING the withdrawal of blood plasma from centrifuged bottles of whole citrated blood a large quantity of valuable erythrocytes remains. When one considers the thousands of bottles of whole citrated blood that are processed into blood plasma the actual amount of discarded erythrocytes is almost unbelievable.

Many institutions are using these cells by resuspending them in certain solutions and administering them intravenously to patients whose primary need is an increase of the erythrocyte content and hemoglobin. In the Mayo Clinic we have used these resuspended cells and found that the incidence of reactions increased according to the age of the blood after the plasma was withdrawn and also according to the time the cells were left resuspended in this new solution before being transfused. Our local supply of cells from the production of plasma was not great. When we had patients to whom we could administer these cells we did not have any cells. Conversely when we had a particular group of cells we did not have any correspondingly grouped patients whose primary need was cells. Consequently our supply of cells as in many other places usually was discarded.

Moorhead and Unger were the first to suggest a new use for these residual erythrocytes. They used the gelatinous mass of cells as dressing material for certain wounds. Their report was very encouraging in that in their opinion this material aided healing processes.

In 1938 to 1940 two of us (T H S⁶ and J S L) in collaboration with Essex⁸ carried out an investigation dealing in part with the ingrowth of vascular and connective tissue in the Clark window. The Clark window used was a specially constructed celluloid apparatus which was placed in the ear of a rabbit by a particular technique. In the course of several days vascular and connective tissue would grow onto the window. Close inspection of Figure 3^{7,4} a will show many fibrils of small vessels growing around the edge of the window. All these small vessels are growing into areas where there is already existent some old blood left from the operative procedure of placing the window in the ear seven days previously. Figure 3 4 b is the same window twelve days after it was inserted. One can see readily the vessels spreading principally into those areas where the old blood is still existent. This is a good example of the new growth of tissue and would lead one to believe that the presence of the blood seemed to have some stimulating effect on the growth of vascular and connective tissue.

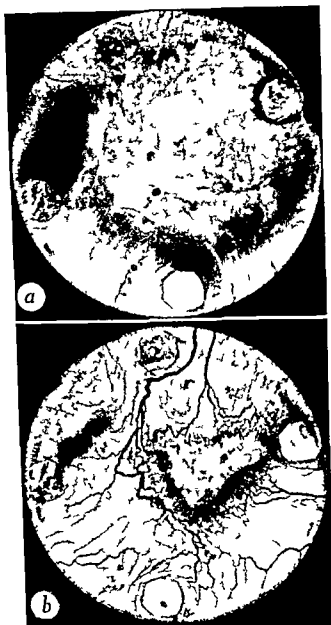


Fig 3 4—*a* A Clark window seven days after its insertion into the ear of a rabbit. Around the edges note small black lines which are newly formed capillaries growing onto the surface of the window. These tiny vessels are more numerous in the region where there is a pre-existing hemorrhage shown as darkened areas on the window than in the nonhemorrhagic region. *b* The same window five days later showing a well vascularized area again more prominent where there is still some pre-existent hemorrhage.

Everybody sees scabs of clotted blood over small cuts and wounds and under these coverings healing is going forward. If the scab is removed too soon a raw surface frequently is found below the covering

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off. One gram of sulfathiazole is added to the cells from each 500 cc of whole citrated blood. The cells from differing blood groups may be mixed together. The process of drying is essentially that of drying blood plasma with certain modifications of the commercial firm.* Data relating to these processes may be detailed at a later time. The powder is sent to us in glass containers suitably sealed. The moisture content remains about 1 per cent or less. Between use the bottles are stored at room temperature. No attempt is made to apply cells of a particular blood group to patients of the same group.

In most cases the base of these wounds has looked devitalized and grayish and has seemed to lack an adequate capillary circulation. Usually daily dressings are done at first. The dried powdered erythrocytes are applied with a sterile spatula or dusted on from a sterile powder container and the wound is covered with a sterile gauze dressing. The skin surrounding the wound is cleansed at each dressing with some aqueous antiseptic solution. No aqueous antiseptic solution is placed deliberately in the wound itself. Occasional swabs are taken from the wounds to follow possible entry of some contaminant. For the first three to five days no change is seen in the wound or ulcer. At the end of this time the base usually begins to show a redder color than before and oozes blood easily apparently from newly formed or else recently opened capillaries. From this time forward it is the usual thing to get a steady progressive ingrowth of granulation tissue and epithelium.

Depending on the case the dressings are done at intervals of one to three days. Frequently a considerable amount of serum is drawn into the wound from underlying tissue producing a sticky mass of cells. The serum that collects under this mass frequently lifts the cells from direct contact with the tissue. In such cases we dress the wound daily removing the layer of cells and the underlying serum. If the cells have formed a so called scab around the edge of the wound we leave this scab alone. This acts as a protective layer to the underlying tissue which in most instances will be an extension of surface epithelium if the wound penetrates epithelium. This scab is left alone unless some specific indication is present for its removal. If it is to be removed it should be soaked with warm compresses to soften it and thus to avoid pulling away the thin layer of skin usually present under it. If this scab is removed too soon one may see capillary oozing from the new tissue.

We have noticed on occasion immediately after the first few applications of powdered erythrocytes that the patient experienced extremely severe burning pain. Sometimes it has been necessary to give a hypodermic of morphine before doing the dressing. In one case it was necessary to spray the ulcer with 0.5 per cent solution of metyrcaine to anesthetize the surface of the ulcer before the cells were ap-

This powder is processed by Baxter Laboratories Inc.

If the scab is left alone and no infection complicates the wound usually complete healing has taken place when the scab falls off

Remembering these two points one can visualize what might be going on under the protective dressing of gelatinous erythrocytic material of Moorhead and Unger Nature makes provision for healing by bleeding into wounds plus the later clotting of blood There probably is some factor in the blood cells that stimulates healing If this is added artificially by dressings of erythrocytes one would expect to get this same action

One of us (J S L) has noted that without chlorophyll plant life dies While chlorophyll is present growth flourishes leaves are green and repair may be carried out During winter the tree or other vegetation is at rest Recently Smith and Livingston published a report dealing with the use of chlorophyll as a dressing of wounds to aid healing In one group of their series of animals 83.3 per cent of the wounds recovered more rapidly when chlorophyll was used as a dressing than when it was not used while in another series there was a 24.0 per cent speed up in time of healing among 67.9 per cent of the cases As plants cannot grow without chlorophyll so the human organism cannot flourish and grow without hemoglobin We are familiar with the patient who has pernicious anemia His general health is not good and his healing processes frequently are slowed The lack of hemoglobin no doubt plays an important role

In 1933 Brunsting and Simonsen reported a series of two hundred cases of cutaneous ulcers treated with the sulfhydryl containing amino acid cysteine They noted two points (1) stimulation of granulation tissue and epithelial proliferation and (2) diminution of drainage with clearing of secondary infection As Brunsting and Simonsen found that an amino acid stimulates repair so Kendall has expressed the opinion that we are dealing in our work with some chemical in the erythrocytes as for example glutathione

A preliminary report⁷ gave examples of three varieties of wounds which appeared to respond to the application of dried erythrocytes Since that report our series of cases has been doubled and a greater variety of types of wounds has been treated these include postoperative wounds of the anterior abdominal wall which have broken down certain postoperative abdominal fistulas and a variety of ulcers on legs as for example ischemic ulcers ulcers due to Buerger's disease ulcers seemingly associated with malnutrition and others that apparently followed slight trauma and refused to heal after months of the usual methods of treatment We feel that the results in this particular series to date have been somewhat more successful than those in our previous report this difference may be due to the slight changes in the technic of treating these wounds

The blood cells are saved after the blood plasma has been aspirated

Young's suggestion that a skin graft appears to take more readily on a base prepared by the dressings of erythrocytes than on a base not so prepared seems to hold true. As a follow up in such a case ten days after a graft dried cells were added to the grafted area and this time it appeared that they improved the extension and growth of the grafted skin.

However this treatment is not a cure for all cases of open wounds. Barker has expressed the opinion that it is an addition to the methods of treatment of certain ulcers and wounds and on the vascular service it has a definite advantage in many cases of stasis ulcers. Buerger's ulcers and certain other ulcers accompanying vascular disease.

REPORT OF CASES

CASE I—The patient a white woman had varicose ulcers, which had been present for many months and which had been treated by various therapeutic

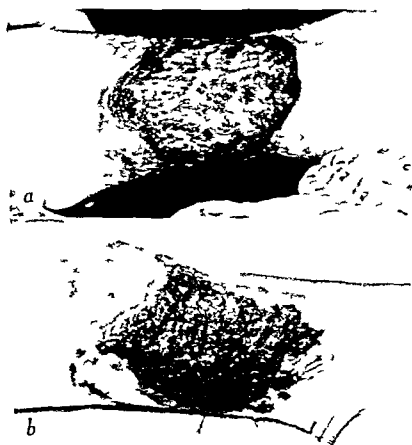


Fig 3 6—*a* Ulcer extending nearly half way around leg about 6 inches (15 cm) long and 1 inch (13 cm) deep. The base was dull gray with a seropurulent discharge. *b* Fifteen days later new epithelial growth is seen around the edge of the ulcer. The base has become filled with granulation tissue level with the surrounding skin and is much healthier in appearance.

measures without any appreciable improvement (Fig. 35a). After daily applications of dried erythrocytes for twelve days the ulcers were practically covered with an epithelial layer (Fig. 35b).

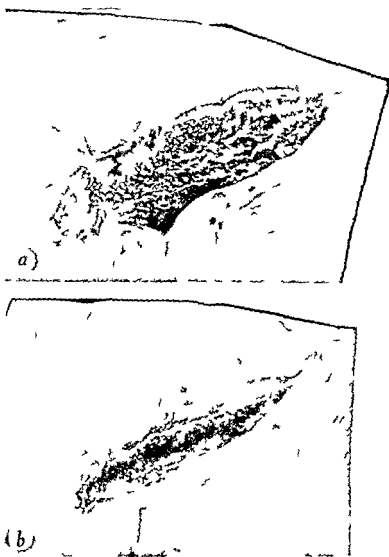


Fig. 327—*a* The incision for the hemorrhoidal artery has widely opened up and the base is covered with a seropurulent discharge. *b* After twenty-one days of application of dried erythrocytes there is considerable decrease of size of the wound. The epithelial tissue is gradually covering the granulation tissue.

CASE II—The patient, a white man, had a large ulcer on the lower part of the leg extending from near the medial malleolus to near the medial malleolus posteriorly. The ulcer was about 6 inches (15 cm) long and 1½ inches (13 cm)

deep (Fig. 3 6 a) Elsewhere it had been treated at intervals for three years by various therapeutic measures—pastes, elastic bandages, cauterization, roentgen therapy and so forth—without benefit. At the Mayo Clinic daily application of dressings of dried erythrocytes was begun. Twelve days later a definite layer of new epithelial tissue had grown on the marginal edge of the ulcer and the base of the ulcer had filled up noticeably with good granulation tissue and had become level with the surface of the skin. Figure 3 6 b shows the ulcer fifteen days after the beginning of treatment. At this time skin grafting was done. Ten days after the graft had been applied erythrocytes were applied to the grafted area. The addition of these dried erythrocytes definitely aided in epithelializing some of the raw surfaces around the edge of the graft.

CASE III.—The patient had a left inguinal hernia. For no apparent reason the tissue broke down completely after operation. The wound, which was approximately 2 inches (5 cm.) wide and 1 inch (2.5 cm.) deep opened up from one end of the incision to the other (Fig. 3 7 a). A small amount of seropurulent discharge was present at the base of the open wound. Daily application of dressings of dried erythrocytes was begun. Twenty-one days after the initial dressing of dried erythrocytes the appearance of the wound was greatly improved (Fig. 3 7 b). The base of the ulcer was level with the surface of the skin. The length of the wound had decreased appreciably and the wound itself was now approximately 1 inch (2.5 cm.) wide. Within a few more days the wound became completely epithelialized and the patient returned home.

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THE RH FACTOR

THOMAS H SELDON JOHN S LUNDY AND R CHARLES ADAMS

LANDSTEINER and Wiener's³ discovery of the Rh factor made an outstanding contribution to the prevention of certain transfusion reactions. The name designating this particular factor is taken from the first two letters of the word rhesus (Rh). Landsteiner and Wiener derived an immune agglutinin which could be produced in rabbits or guinea pigs by repeated injections of the red cells of the rhesus monkey. By using this guinea pig or rabbit immune serum and suitably mixing it with human red blood cells they were able to subdivide each of the four groups of human blood into two specific classes: (1) blood known as Rh positive blood, whose red cells when mixed with this specific immune serum give an agglutination similar to that which occurs when red cells from the rhesus monkey are mixed with this immune serum; (2) blood—so called Rh negative blood—whose red cells when mixed with this particular immune serum do not give any agglutinating reaction.

About 85 per cent of all human beings have this Rh factor present in their red blood cells. There is no very definite information relative to the physical properties of this Rh substance. It is presumed to be a carbohydrate fixed to the proteins of the red blood cells. It is not present in commercial plasma or serum.¹ The antibodies which are formed against this particular Rh factor are present in the serum or plasma of the blood. Antibodies are probably protein in nature and are contained in the globulin fraction of the blood.

Landsteiner and Wiener⁴ have shown that the Rh factor in the blood cells is transmitted in the human offspring as a simple mendelian dominant. Briefly, the proportional incidence of presence of the Rh factor when the parents are respectively both positive, one positive and one negative, and both negative is approximately:

Rh+	Rh+	76 per cent of children	Rh—
Rh+ × Rh—		76 per cent of children	Rh—
Rh— × Rh—		100 per cent of children	Rh—

The dispersion of the Rh factor does not vary significantly among any of the four blood groups; also, it is evenly divided between sexes. The Rh factor when positive can be shown to be present in the fetal blood circulation and, once established, the Rh factor remains constant.¹⁰

TESTING FOR THE RH FACTOR AT THE CLINIC

At the Clinic² the testing serum is produced by two injections of rhesus monkey cells into guinea pigs. The procedure whereby five injections of monkey cells are made into guinea pigs as advocated by Landsteiner and Weiner³ was tried but the final serum did not prove as satisfactory as when the guinea pigs received only two injections of red blood cells. The testing serum is inactivated. The potency of the guinea pig serum is tested by making serial dilutions and mixing with known Rh positive and Rh negative red cells. The same technic is used in the primary determination of the presence or absence of the Rh factor in human cells. This technic is based on the observation that when a suspension of red blood cells is mixed with an indifferent serum in small tubes red blood cells settle out normally, thus giving a sharply defined border. When this occurs no Rh factor is present in the cells. However, if the cells are agglutinated—that is, if there is an interaction of Rh positive cells and anti Rh immune serum—an examination of the edge of the clump of cells shows a very irregular and wrinkled appearance.

For testing human serum to discover the presence or absence of anti Rh agglutinins, tests are made against a series of bloods of known Rh type using compatible blood groups. Guinea pig serum usually reacts best at room temperature, whereas human serum usually reacts best at body temperature. However, with unknown serum various temperatures should be tried. Reactions are generally sufficiently developed in one hour that they may be read. At the Clinic we have a list of known Rh negative and Rh positive persons from whom we can draw blood for specific testing.

It is recognized that an Rh positive person (85 per cent of all persons) cannot become immunized against the Rh factor. However, persons who belong to the Rh negative classification (15 per cent of persons) may acquire specific anti Rh immune bodies, and because of this fact serious complications may develop. If all persons who were Rh negative produced anti Rh immune bodies as a result of repeated blood transfusions or pregnancies, the incidence of serious complication would be greatly increased. Indeed, it is very fortunate for these Rh negative persons that the production of specific anti Rh immune bodies does not occur more commonly than it does.

PRODUCTION OF ANTIBODIES BY REPEATED TRANSFUSIONS

If the prospective recipient belongs to the Rh positive classification, the whole problem of reactions due to the interaction of Rh positive blood and anti Rh immune serum may be dismissed as an Rh positive person does not produce any anti Rh immune bodies. However, an

Rh negative recipient may be stimulated to produce anti Rh immune bodies if he receives one or more transfusions of Rh positive blood.

The duration of time between the transfusion of the first Rh positive blood and the appearance of anti Rh immune bodies varies. It is felt that five days is the usual shortest period. When Rh positive blood is transfused into a patient who is Rh negative and has anti Rh immune bodies present in his plasma a reaction would be expected. After this reaction all the anti Rh immune bodies may have been united with Rh positive factor temporarily producing an absence of the immune bodies. These immune bodies ordinarily reappear within three to five days. For this reason it has been suggested that when repeated transfusions are necessary they should be administered at two to four day intervals. Such a procedure does not necessarily prevent all reactions; however the reaction may be very mild and is certainly likely to be less dangerous than a reaction produced by transfusion of Rh positive blood at longer intervals than two to four days. Occasionally it is difficult to distinguish between a weakly reacting Rh positive person and an Rh negative patient who has had transfusions of blood from an Rh positive donor. In the latter case the donor's Rh positive cells still present in the recipient's circulation react against the anti Rh testing serum and one may think that the patient is Rh positive instead of Rh negative. Therefore one may feel safe when actually a potential transfusion reaction may be in the offing.⁸

If the patient is suspected of needing multiple transfusions it is well to have him tested for the presence or absence of the Rh factor before any transfusions are administered.

CASE I—The patient, a married woman aged thirty three years. She had had three children born alive and all died with no history relevant to the present illness attributable to any pregnancy.⁹ On September 23, 1943, this patient had received blood transfusion. Her husband's blood was incompatible and cross matched. Transfusion of 500 cc of stored blood had been performed by the indirect method. During the day the patient had had slight rise of temperature (100.4 F). However her temperature quickly returned to normal. No significant attack due to this rise of temperature. It was perhaps a mild pyrogenic reaction. On September 24, the patient had received a second transfusion of 500 cc of stored blood from a second incompatible donor whose blood also had been cross matched. On the second day after the transfusion chills, a temperature of 105 F, headache, nausea, pulse rate 140 and respiration 32 had developed. Within a few hours the patient's condition had turned to normal. No other suggestive laboratory work had been done at this time.

On September 9, the patient was brought to the Clinic on account of secondary anemia and vaginal bleeding. A blood transfusion was decided upon to p

The attending hospital physician found enough to forward us a complete history of the case and samples of blood from the first two blood donors. Laboratory examination showed that both bloods were group B and both were in the Rh positive classification.

pare her for operation. Laboratory investigation revealed that the patient was group B Rh negative and specific anti Rh immune bodies had developed in her serum. She was transfused with 500 cc of citrated blood which had been withdrawn from a compatible donor (group B) belonging to the Rh negative classification. This blood was received by the patient uneventfully. The anti Rh immune bodies of the patient showed a reaction in a dilution of 1:64. A further interesting point was that one month later this patient was tested again for the presence of anti Rh immune bodies and they were found to be entirely absent.³

The reaction after the first transfusion that this patient received resembled a reaction due to pyrogens. The second transfusion was given relatively soon and one would not ordinarily expect the anti Rh immune bodies to have developed to a degree sufficient to produce as serious a reaction as this patient had.

However, by the time the third transfusion was contemplated a sufficient time had elapsed to produce anti Rh immune bodies. The donor of the blood given in the third transfusion belonged to the Rh negative classification. There was no reaction to this transfusion.

IMMUNE BODIES DEVELOPED IN THE MOTHER DURING PREGNANCY

For this occurrence a prospective mother must belong to the Rh negative classification. The father of the child must belong to the Rh positive classification. The fetus must also belong to the Rh positive classification.

Reports in the literature lead one to believe that isoimmunization as the result of pregnancy occurs far more frequently than isoimmunization from repeated blood transfusions. In the majority of these cases the Rh factor in the fetus is responsible for the isoimmunization. During the interval of pregnancy the specific anti immune bodies may develop in the mother between the eighth and the twelfth week. Some writers suggest the possibility that the specific red cells of the fetus escape from the fetal circulation into the mother's circulation. Other writers suggest that there is an exchange of the Rh factor from the fetal circulation to the mother's circulation and that the stimulating factor then acts on the mother to produce these specific anti Rh immune bodies. These specific anti Rh immune bodies in turn are passed back into the fetal circulation where they may react on the red blood cells of the fetus. A greater or lesser destruction of the red blood cells of the fetus is produced and one of two things may happen: (1) the child may die in utero and the pregnancy end in a miscarriage or (2) the child may be born alive and after birth exhibit the symptoms of erythroblastosis foetalis. At the time of the miscarriage or the termination of the pregnancy the mother may suffer from a very severe hemorrhage. This sequence of events has been suggested as being one of the main causes of repeated early abortions.

Sometimes it happens that the first child is delivered alive and well but that subsequent pregnancies are terminated as described. This may be because the first fetus is Rh negative or because the mother needs two or more pregnancies and Rh positive fetuses before her anti Rh immune bodies are of sufficient titer to do any severe damage.

Let us suppose that the fetus dies in utero. Perhaps before delivery of the dead fetus the mother's general condition may warrant a blood transfusion or the dead fetus may be delivered and a transfusion may be advisable because of a severe hemorrhage and shock. The mother is Rh negative and has anti Rh immune bodies. If Rh positive blood is given to this patient she probably will have a severe hemolytic reaction with its subsequent complications for example anemia possible death and so on.

CASE II—In 1932 the patient was delivered of a healthy child. Delivery was uneventful. In 1934 the patient was several months pregnant and was referred to the Clinic because of severe secondary anemia. The concentration of hemoglobin was 4.0 gm per 100 cc of blood. She belonged to group A and received 500 cc of transfused blood from her husband who belonged to group A. Following transfusion severe chill, a temperature of 104° F and jaundice developed on the second day with intense hemoglobinuria. On the second day the patient was delivered of stillborn twins. On the third day rigor appeared and the concentration of urea was elevated to 170 mg per 100 cc of blood. Pilonary edema was present on the fourth day. Intravenous fluids were being used. By the seventh day the patient was showing improvement and the remainder of her stay in the hospital was relatively uneventful. In 1935 she had a miscarriage at the second month of pregnancy. Complication from this miscarriage was uneventful.

In 1936 the patient returned to the Clinic for anticipated delivery. Because of anemia the concentration of hemoglobin being 3.8 gm in each 100 cc of blood she was transfused with 500 cc of blood. The transfusion was performed before the existence of the Rh factor was discovered but recent testing of the donor from whom the blood was obtained showed that the patient was given Rh positive blood. On the second day after the transfusion the patient was slightly jaundiced. It is difficult to say whether the jaundice was an accompaniment of the anemia or was due to the blood transfusion. At this time the patient was delivered of a normal female child. At delivery because of grade I shock the patient received 400 cc of 6 per cent solution of acacia and 600 cc of 10 per cent solution of glucose in isotonic saline.

In 1943 the patient who was again pregnant returned to the Clinic because of her previous history of blood transfusion reactions and stillbirths. A laboratory investigation was done at this time. Her husband (first donor in 1934) was Rh positive. The patient was Rh negative and had anti Rh immune bodies present in her serum. One month before delivery fetal movements stopped. We were prepared to give her Rh negative blood at the time of delivery if it was necessary. At delivery a macerated fetus expelled and a severe and almost uncontrollable hemorrhage followed. Within one hour this patient received 2400

We have tested this donor as she sits still on the p. f. s. n. l. donor list.

of Rh negative blood. During the first postpartum day she received another 600 cc of Rh negative blood. From this Rh negative blood the patient did not experience any reaction whatsoever. Her whole postpartum convalescence was uneventful.

It might be said: Never use a husband as a prospective donor for a wife particularly during pregnancy. The safe procedure is to use Rh negative donor blood for all Rh negative women during pregnancy.

ERYTHROBLASTOSIS FOETALIS

Levine and Katzin⁵ found that a correlation exists between the occurrence of intragroup transfusion reactions in postpartum cases due to the Rh factor and complications in pregnancy. Later Levine and his co-workers⁶ gathered evidence that the Rh factor plays an important role in pathogenesis in the majority of the cases of erythroblastosis foetalis. In a typical case the father must be Rh positive, the mother Rh negative and the fetus Rh positive. The Rh factor must travel from the fetal circulation over to the maternal circulation and stimulate the formation of the antibodies. These in turn filter back to the fetal circulation. Death of the fetus in utero or birth of a child which may show varying degrees of severity of erythroblastosis foetalis may ensue. The severity of the disease may vary from death within a few hours of birth to a very mild limited hemolysis which terminates favorably without specific treatment. A suspicion of erythroblastosis foetalis is possible before the child is born. Such a suspicion is based on the history, the results of laboratory examination of the father's and mother's blood and so on.

The hemolysis of the child's blood is due to the action of the anti Rh immune bodies on the red cells producing actual destruction of the red blood cells. The symptoms of the active destruction of cells make their appearance a few hours to a few days after birth and usually are characterized by deepening jaundice, bile-colored urine, anemia, hyperplasia of blood forming tissue, immature red cells, edema, petechial hemorrhages, sometimes necrosis of the liver and occasionally damage of the brain.

As long as antibodies are present in the child's circulation active destruction of the child's own cells will occur. Theoretically any compatible Rh positive or Rh negative blood, excluding the mother's blood, may be given to the child. If Rh positive blood is given to the child the immune bodies present in the child's circulation will combine with the Rh positive cells. This will aid in ridding the child's circulation of the anti Rh immune bodies.

Some investigators advocate giving the mother's blood if necessary. This procedure does transfer more antibodies to destroy the child's own blood, however they feel that the mother's cells will suffice the

child's needs until a suitable donor is made available. Transfusion of the mother's blood should be practiced only in case of an extreme emergency. It would be better to transfuse the father's blood (Rh positive) in larger quantities to take up the immune bodies and also leave some blood for the child's needs.

At the Clinic we have a list of professional donors comprising all blood groups. This list is also divided into Rh positive and Rh negative blood classification and consequently we can obtain fresh Rh negative blood relatively easily. It is our practice to give small daily transfusions to these erythroblastotic babies using group O Rh negative blood.

CASE III—The first child was born alive but died shortly after birth. The second child was born alive and was brought to the Clinic in July 1943. It is a sufferer from jaundice, and the Laboratory examination revealed anemia progressing as jaundice and bleeding from the mother's blood as found to be Rh negative with immune bodies. The father's blood is Rh positive and the baby's blood is Rh positive. As a result of past small daily transfusions for jaundice the child was able to return home. It is very nice & successful.

The third child born in July 1943 was brought to the Clinic for observation and treatment of jaundice. On arrival at the Clinic twenty-four hours after birth the jaundice was very bad and needed immediate treatment. The first few petechial hemorrhages were present. Erythroblastosis fetalis was diagnosed and a transfusion of 30 cc of Rh negative group O blood was administered immediately. In addition to the transfusions of 30 to 50 cc of group O blood was administered. It is interesting to note that in four of the twelve transfusions Rh positive group O blood was used and that subsequently the red blood cell count was the same before the transfusion. After the eighth transfusion of Rh negative group O blood the red blood cell count and percentage of hemoglobin increased. The infant is healthy and content after the transfusions.

We feel that, if possible, these babies should be transfused with group O Rh negative blood.

SUMMARY

In general the Rh factor in certain respects is somewhat similar to other substances which determine blood grouping. Rh positive persons cannot become immunized against the Rh factor. Anti Rh immune bodies may develop among Rh negative persons either by repeated blood transfusions or during pregnancies. The antigenic strength of the Rh factor varies. Some persons never form any anti Rh immune bodies while others form them strongly.

During pregnancy anti immune bodies may develop in the mother between the eighth and the twelfth week. It is wise never to use a husband as a prospective donor for these patients. In fact it might be

well to make a rule that husbands should never be used as donors when their wives are being transfused during pregnancies or postpartum

Multiple transfusions should be done carefully. The test for the Rh factor should be performed. If the recipient is Rh positive nothing further need be done as a safeguard against reactions attributable to the anti Rh immune bodies. However if the recipient is Rh negative care must be exercised in repeated transfusions to see that anti Rh immune bodies are not developing. If anti Rh immune bodies are developing then subsequent donors must belong to the Rh negative classification.

For transfusions into erythroblastotic babies group O Rh negative blood should be used.

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BRONCHOLITHIASIS

WILLIAM S. TINNEY AND HERMAN J. MOERSCH

THAT calcareous material may be expectorated in the sputum has been known since the time of Aristotle. In spite of this fact few references to the phenomenon have appeared in the English literature. Lloyd¹ reviewed this literature from 1900 to 1930 and found only eighteen cases of this type reported. He added four cases of his own. Since Lloyd's article reports of one case have been made by Moersch,⁴ Schmidt,⁷ Maytum and Vinson,³ and Myers.⁵ Pendergrass and de Lorimer⁶ have added two cases as have VanOrdstrand, Moore and Harris,⁹ this makes a total of thirty cases reported in American and British literature since 1900. These figures, however, do not represent the real incidence of broncholithiasis. This is borne out by the fact that we have been able to collect records of twenty-eight such cases from the files of the Mayo Clinic. Furthermore, Sternberg,⁸ in a study of 6132 cases in which necropsy was performed, noted thirty-two instances in which there was evidence of perforation into the tracheobronchial tree of an anthracotic node.

Calcareous concretions present in the tracheobronchial tree have been described under a variety of terms such as lung stone or calculus, bronchial stone or calculus, pulmolith and pneumolith. More recently this clinical entity has been generally designated as broncholithiasis.

Broncholiths may originate within or around the bronchi. Previously aspirated foreign bodies and endobronchial secretions may act as nuclei for the deposition of calcium. Inflammatory processes within the air passages sometimes lead to the necrosis of bronchial and tracheal cartilages which may likewise act as nuclei in the formation of broncholiths. Broncholithiasis has been noted particularly in cases of prolonged pulmonary suppuration such as pulmonary abscess and bronchiectasis. In the majority of cases the calculus develops extrabronchially by the calcification of tracheobronchial lymph nodes. The process in most instances is the sequela of an old tuberculous infection within the nodes. Because of the proximity of these calcified nodes to the respiratory tract they may erode or ulcerate through the bronchial wall, gain access to the lumen of the bronchus and become broncholiths. Such a broncholith acts in the same manner as an aspirated foreign body. It may remain dormant in the bronchial tree for a considerable period of time, but its presence eventually tends to lead to pulmonary suppuration unless it is expectorated.

Calculi vary considerably in size, shape and consistency, are usually

grayish white and may be single or multiple. They usually are hard and gritty but occasionally are soft and putty like. They are customarily rough and irregular and may be faceted when the stones are multiple. In most instances they are composed of 85 to 90 per cent calcium phosphate and from 10 to 15 per cent calcium carbonate.

CLINICAL FEATURES

Broncholiths have no predilection for either sex or for any age group. In our series fifteen patients were males and thirteen females. The age of the youngest patient was thirty-two years and of the oldest sixty-nine years.

The symptoms produced by a broncholith depend on the size and shape of the calculus, the degree and duration of the bronchial obstruction and the secondary changes which may take place in the pulmonary tissue distal to the point of obstruction. The erosion of a calcareous gland into the tracheobronchial tree generally is heralded by a paroxysmal cough of sudden onset, often associated with thoracic oppression, substernal constriction or a severe tearing sensation. The more severe attacks have been aptly designated bronchial colic in an attempt to compare them with biliary or urinary colic. The paroxysm often is followed by a sensation that something has torn loose and symptoms are usually relieved dramatically when the calculus is expelled. Cough was a prominent symptom in every one of our cases; in 50 per cent, it was severe and paroxysmal. Thoracic pain was an important feature in thirteen (46 per cent) of our cases and in 26 per cent the pain was severe. Case I illustrates the rather typical attacks of cough and pain caused by a broncholith.

CASE I—A man fifty-nine years old came to the Clinic December 193 because of cough and expectoration of eight months' duration. The cough occurred in attacks lasting about thirty minutes, was extremely severe and was followed by a whoop so marked that the family physician made a tentative diagnosis of whooping cough. The cough was associated with severe sharp substernal pain and was productive of a moderate amount of thick purulent sputum.

A roentgenogram of the thorax revealed an area of calcification along the left border of the heart with inflammatory changes at the left base (Fig. 3-8 *a*). Bronchoscopic examination revealed a large pulmonary stone situated in the left lower lobe bronchus almost completely obstructing the bronchus. The calculus was removed in pieces and the bronchus thoroughly aspirated. Following this procedure the patient's symptom lessened. A roentgenogram of the thorax made two days later revealed marked improvement (Fig. 3-8 *b*). The broncholith is shown in Figure 3-9.

The paroxysmal cough may or may not be accompanied by a so-called asthmatic wheeze which has been given the descriptive term

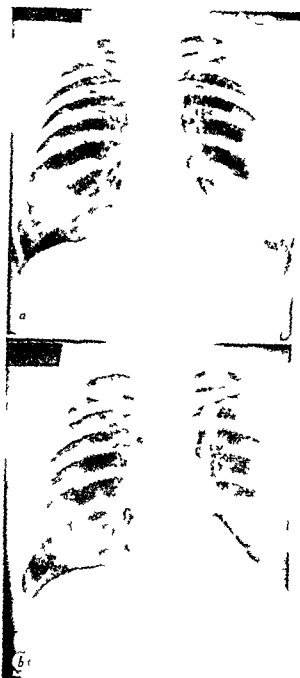


Fig 38 (Case I) — Broncholith in left lower lobe bronchus with partial atelectasis of left lower lobe. b disappearance of atelectasis two days after removal of broncholith.

'stone asthma' Most patients experience some expiratory dyspnea during the process of expulsion In five of our cases (18 per cent) the



Fig 329 (Case I) —Broncholith

clinical course was characterized by an intractable asthma that was dramatically relieved when the broncholith was expectorated or removed

CASE II—A man aged fifty three years came to the Clinic April 30 1943 because of a productive cough which had been present since November 1942 Since the onset of his illness he had had severe attacks of asthma every day and had not obtained any relief from epinephrine The asthma was initiated by paroxysms of coughing and was characterized by dyspnea wheezing and orthopnea Attacks of chills and fever occurred frequently The patient had lost 27 pounds (10 kg) since the onset of his illness

Examination of the thorax revealed decreased expansion of the left side with decreased tactile fremitus and many coarse rales over the base of the left lung A roentgenogram of the thorax revealed an area of infiltration at the left base (Fig 330 a) At bronchoscopic examination the left lower lobe bronchus was found to be almost completely occluded by multiple broncholiths These were removed without difficulty Following this procedure all pulmonary symptoms disappeared immediately A roentgenogram of the thorax made five days after the removal of the broncholiths indicated marked improvement (Fig 330 b) The broncholiths removed are shown in Figure 331

Hemoptysis usually is noted during or immediately after expectoration of the calculus This symptom was present in eighteen cases (64 per cent) of our series In eight cases (29 per cent) hemoptysis was severe

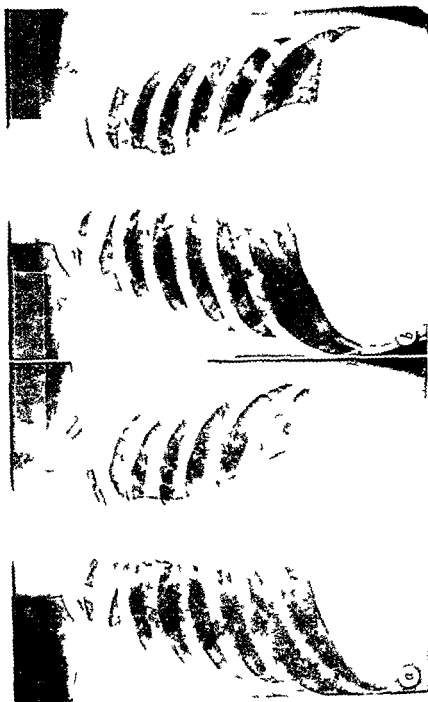


Fig 330 (C) -- After 1 yr of left lower lobe resection, the lung has almost disappeared.

Patients may suffer from multiple attacks during which they expectorate calcareous material. Elliott¹ reported a patient who expectorated a total of fifty six stones. In our series there were nine cases (32 per cent) in which the clinical course was characterized by the expulsion of multiple calculi. One of the patients expectorated an estimated 100 concretions in eighteen years. A roentgenogram of the thorax in this case revealed miliary areas of calcification scattered throughout the lungs.

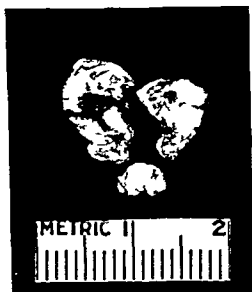


Fig. 331 (Case II) —Broncholith

Not infrequently the clinical features are less dramatic than those that we have described thus far. They may consist of bouts of chills and fever, recurrent pneumonia, malaise and loss of weight. Fourteen of our patients (50 per cent) had recurring attacks of chills and fever that were usually diagnosed influenza or pneumonia. This symptom complex is well illustrated in Case III.

CASE III—A woman aged fifty-one years entered the Clinic June 7, 1941, complaining of cough which had persisted since an attack of influenza in November 1940. This acute illness was characterized by chills, fever and profuse sweating. The cough had been productive of a small amount of thick mucus which was occasionally tinged with blood. Prior to her admission to the Clinic a diagnosis of unresolved pneumonia of the right lung had been made.

A roentgenogram of the thorax (Fig. 33 a) revealed atelectasis of the right upper lobe with multiple areas of cavitation. Examination of the sputum was negative for *Mycobacterium tuberculosis*. At bronchoscopic examination a polypoid lesion was seen projecting from the orifice of the right upper lobe bronchus. This lesion was found to be a broncholith deeply imbedded in the bronchial wall; an attempt at removal was unsuccessful. The upper lobe bronchus was



Fig 33 (Ca c III) --a Bronchial obstruction right upper lobe bronchus causing atelectasis of the right lung
 genogram limonite condensation in the right lung
 b tracheal deviation to the right
 c postoperative of the right lung
 d postoperative of the left lung

dilated and immediately after the examination the patient coughed up the large broncholith. The patient's pulmonary symptoms improved. A roentgenogram of the thorax taken subsequently revealed a marked clearing of the lung (Fig. 33 b). The broncholith is shown in Figure 33.

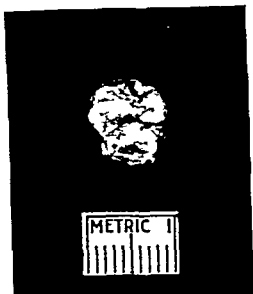


Fig. 333 (Case III) —Broncholith

If the broncholith is not removed or expelled spontaneously, dangerous sequelae in the form of bronchiectasis or pulmonary abscess are likely to occur. In ten cases (36 per cent) of this series pulmonary suppuration was secondary to the prolonged bronchial obstruction. In one of these cases a fatal metastatic abscess developed in the brain nine months after the onset of pulmonary symptoms.

In many cases the diagnosis is made after expectoration of the calculus. Occasionally the patient's history and the demonstration of calcification in the roentgenogram of the thorax may lead to a tentative diagnosis of broncholithiasis. Confirmation depends on visualization of the stone in the sputum or at bronchoscopic examination.

PROGNOSIS

In general the prognosis in cases of broncholithiasis is excellent. This is particularly true if the concretion is expelled spontaneously or removed bronchoscopically soon after the onset of pulmonary symptoms before the occurrence of bronchiectasis or pulmonary abscess in the tissue distal to the site of the bronchial obstruction. In sixteen cases (57 per cent) in our series removal of the calculus resulted in dramatic and almost immediate cessation of all pulmonary symptoms. The most striking results were noted in cases in which asthma was

severe. The relief of symptoms following removal of the broncholith was less spectacular in three cases in which destruction of pulmonary tissue had resulted from abscesses; in four cases of extensive hilar calcification and in two cases of miliary calcification of the lung.

COMMENT AND SUMMARY

The origin of broncholiths may be endobronchial or extrabronchial. In most instances they arise from calcified tuberculous peribronchial lymph nodes that gain entrance to the lumen of the bronchus by erosion and ulceration.

Twenty-eight cases of broncholithiasis were drawn from the files of the Clinic and the various pulmonary symptoms resulting from the attempted expulsion of the calculus were studied.

Whenever there is evidence of an obstructing lesion of the bronchus a broncholith should be suspected as well as an aspirated foreign body and a bronchiogenic carcinoma. The diagnosis of broncholithiasis depends on visualization of calcareous material in the sputum or at bronchoscopic examination.

In general the prognosis is excellent. The most dramatic results following removal of a broncholith are noted in the cases of asthma (stone asthma). If the broncholith is not expelled or removed bronchiectasis or abscess almost inevitably results.

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BRONCHOGENIC CARCINOMA

O THERON CLAGETT AND G V BRINDLEY JR

THE relative frequency and apparently increasing incidence of bronchogenic carcinoma indicate the growing importance of this disease. As late as 1912 Adler collected 274 cases of carcinoma of the lung and stated "On one point, however there is nearly complete consensus of opinion and that is that primary malignant neoplasms of the lung are among the rarest forms of disease." Now carcinoma of the lung is second and almost equal in incidence to carcinoma of the stomach as demonstrated in the reports of Kikuth, Koletsky and Brines and Kenning. Statistics from necropsies clearly indicate that this increased incidence is real and not just apparent. Ochsner and DeBakey stated that in the necropsies performed at the Charity Hospital in New Orleans the incidence of bronchogenic carcinoma increased to approximately five times its former figure in a period of seven years and now equals the incidence of carcinoma of the stomach. Olson found that the incidence of pulmonary carcinoma in the necropsies at Boston City Hospital increased from 7.5 per cent of all carcinomas in 1929 to 19.1 per cent in 1934. Further comprehension of the frequency of carcinoma of the lung may be gained from the fact that about 15,000 persons die annually of bronchogenic carcinoma in this country.

ETIOLOGY

Numerous theories have been suggested to explain the increased incidence of pulmonary carcinoma. The opinion has been expressed by several writers^{2, 3, 4} that *influenza* produces metaplasia of the bronchial epithelium which may develop into carcinoma. Fried⁵, Kikuth, Simpson and Hueper after careful studies however concluded there was no significant relation between influenza and bronchogenic carcinoma. Ewing, 1928, stated that tubercle bacilli had an irritating effect on the bronchial mucosa and was an important etiologic factor in pulmonary malignancy. Larron, Cherry, Wolf and Fried⁶ also expressed the opinion that *pulmonary tuberculosis* might be a precursor of carcinoma of the bronchus. However, Pearl, Kikuth, Sison and Monserrat found the two lesions rarely associated. Pearl concluded that the infrequent development of the two lesions in the same person is apparently due to a significant antagonism between the two pathologic phenomena which disappears when and if the tuberculous process retrogresses or heals particularly by the fibrotic route.

Bronchiectasis and *chronic bronchitis* have been mentioned frequently as etiologic factors in bronchogenic carcinoma. Chronic pulmonary suppurative disease often is associated with carcinoma of the lung and the development of bronchogenic carcinoma has been reported in patients who have had bronchiectasis for several years. Metaplasia in the presence of bronchiectasis has been observed in experimental animals and it has been suggested that similar precancerous changes may develop in the human being.

Syphilis has been proposed as an etiologic factor. Simpson, Letulle and Popper have observed the coexistence of these lesions. However the evidence advanced so far seems insufficient for considering pulmonary syphilis a precancerous lesion.

The *inhalation of irritating gases* such as exhaust gas from combustion motors and gases arising from tarred roads has been proposed as a possible cause of pulmonary carcinoma. Many experiments seem to substantiate this belief. However the incidence of bronchogenic carcinoma reported in those regions where the roads have not changed nor the number of cars increased has increased definitely. After a thorough study of the situation most investigators of the subject have concluded that the inhalation of tar and benzene products is of little significance in the production of pulmonary carcinoma.

It has been stated many times that the *inhalation of radioactive substances* will cause the development of carcinoma of the lung. This fact has been demonstrated conclusively by the high incidence of bronchogenic carcinoma in the workers at the Schneeberg radium mines. As many as 62 per cent of the workers who were followed until death died of primary pulmonary carcinoma.⁹

Conflicting reports have been made concerning the etiologic importance of *pneumoconiosis*. Some investigators^{2, 6} have expressed the opinion that silica and other agents producing pneumoconiosis are important etiologic agents while other extensive reviews^{14, 3} of clinical and necropsy cases do not indicate any more frequent occurrence of bronchogenic carcinoma in persons who have pneumoconiosis or silicosis than in the general population.

The opinion frequently has been expressed that the increase in bronchogenic carcinoma may be due to the increase in smoking and the *inhalation of smoke*. Nicotine, pyridine bases, phenol bases, ammonia and certain added hygroscopic agents all have been shown to act as irritants to the bronchial mucosa. Pulmonary carcinoma has been produced in experimental animals by the tar from cigarette smoke. Ochsner and DeBaley concluded: "It is our definite conviction that the increase in the incidence of pulmonary carcinoma is due largely to the increase in smoking, particularly cigaret smoking, which is universally associated with inhalation."

MATERIAL STUDIED

During the period January 1 1925 to about October 1 1943 the clinical diagnosis of bronchogenic carcinoma was made in 1101 cases at the Clinic. In 493 of these cases the diagnosis was corroborated by biopsy of a specimen of the primary lesion obtained at the time of bronchoscopic examination. Exploration was thought to be feasible in ninety cases 18 per cent of the cases of microscopically proved carcinoma of the bronchus or 8 per cent of the whole group in which the diagnosis was made clinically.

It should be recalled in regard to these figures that the complete series includes all the cases in which the clinical diagnosis of bronchogenic carcinoma was made at the Clinic from January 1 1925 to October 1 1943 while the surgical treatment of carcinoma of the bronchus has been developed only in the past twelve years.

In a series of cases in which exploratory thoracotomy was performed the lesions in forty five cases were considered suitable for surgical extirpation this gives a resectability rate of 50 per cent. The data presented in this paper are drawn from the ninety cases of bronchogenic carcinoma in which exploratory operation was performed at the Clinic. The forty five cases in which the lesion was removed will often be referred to as the operable group and the other forty five as the inoperable group.

INCIDENCE

Sex—Pulmonary carcinoma seems to occur predominantly among males. Various figures have been given but most writers have stated

TABLE 1—AGE OF PATIENTS IN NINETY CASES IN WHICH EXPLORATORY OPERATION FOR BRONCHOGENIC CARCINOMA WAS PERFORMED

Age yrs	Operable Lesion		Inoperable Lesion	
	Patients	Per cent	Patients	Per cent
1 to 19	1	2		
20 to 29	3	7	1	2
30 to 39	6	13	4	9
40 to 49	14	31	14	31
50 to 59	19	42	21	47
60 to 69	2	4	5	11
Total patients	45		45	

Percentages in each group are based on total patients in group

Bronchiectasis and *chronic bronchitis* have been mentioned frequently as etiologic factors in bronchogenic carcinoma. Chronic pulmonary suppurative disease often is associated with carcinoma of the lung and the development of bronchogenic carcinoma has been reported in patients who have had bronchiectasis for several years. Metaplasia in the presence of bronchiectasis has been observed in experimental animals and it has been suggested that similar precancerous changes may develop in the human being.

Syphilis has been proposed as an etiologic factor. Simpson, Letulle and Popper have observed the coexistence of these lesions. However the evidence advanced so far seems insufficient for considering pulmonary syphilis a precancerous lesion.

The *inhalation of irritating gases* such as exhaust gas from combustion motors and gases arising from tarred roads has been proposed as a possible cause of pulmonary carcinoma. Many experiments seem to substantiate this belief. However the incidence of bronchogenic carcinoma reported in those regions where the roads have not changed nor the number of cars increased has increased definitely. After a thorough study of the situation most investigators of the subject have concluded that the inhalation of tar and benzene products is of little significance in the production of pulmonary carcinoma.

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The opinion frequently has been expressed that the increase in bronchogenic carcinoma may be due to the increase in smoking and the *inhalation of smoke*. Nicotine, pyridine bases, phenol bases, ammonia and certain added hygroscopic agents all have been shown to act as irritants to the bronchial mucosa. Pulmonary carcinoma has been produced in experimental animals by the tar from cigarette smoke. Ochsner and DeBakey concluded "It is our definite conviction that the increase in the incidence of pulmonary carcinoma is due largely to the increase in smoking, particularly cigaret smoking which is universally associated with inhalation."

pathetic nerves. Pulmonary symptoms appear relatively late in the disease; the diagnosis depends primarily on roentgenographic examination.

The most common symptoms in our series and their percentage of occurrence are given in Table 2.

TABLE 2—SYMPTOMS IN NINETY CASES IN WHICH EXPLORATORY OPERATION WAS PERFORMED

Symptoms	Operable Lesion		Inoperable Lesion	
	Cases	Per cent	Cases	Per cent
Cough	41	91	34	16
Hemoptysis	28	67	21	4
Loss of weight	26	58	28	62
Pain in thorax	26	58	28	67
Dyspnea	19	42	19	47
Total cases	45		45	

Percentages based on total cases in group

TABLE 3—DURATION OF SYMPTOMS IN NINETY CASES OF BRONCHOGENIC CARCINOMA IN WHICH EXPLORATORY OPERATION WAS PERFORMED

Duration, mos.	Operable Lesion		Inoperable Lesion	
	Cases	Per cent	Cases	Per cent
1 to 6	18	40	23	51
7 to 12	15	33	1	38
13 to 18	4	9	2	4
19 to 24	4	9		
24 to 30			3	1
36	4	9		
Total cases	45		45	

Percentage is based on total cases in group

Duration of Symptoms.—Differences of opinion have been expressed as to the rapidity of the growth of carcinoma of the bronchus but

the usual reported interval from the onset of symptoms until the time of death is relatively short. The duration of symptoms in our cases from their first recognition until the patient reported at the Clinic for examination is given in Table 3.

DIAGNOSIS

Numerous aids have been proposed to assist in the diagnosis of pulmonary carcinoma. Roentgenographic and bronchoscopic examinations combined with microscopic study of specimens of tissue taken from the primary lesions are the most important diagnostic methods. In the operable group in this series the presence of the lesion was suspected at the time of the roentgenographic examination in thirty-six cases (80 per cent) and unsuspected in nine cases (20 per cent). In the inoperable group the lesion was thought to be present in forty-two cases (93 per cent) and unsuspected in three cases (7 per cent).

It is now a widely accepted axiom that bronchoscopy should be employed as a routine procedure in practically all cases in which primary carcinoma of the bronchus is suspected. At an early stage this is the only method by which tissue can be obtained for the establishment of a positive microscopic diagnosis. In those cases in which a positive diagnosis cannot be made by biopsy, changes in the bronchial wall at times may suggest the presence of a malignant lesion.

Bronchoscopic examination was carried out in forty-four of the cases in which the lesions were operable in our series and a positive diagnosis of carcinoma of the bronchus was made in thirty-seven (84 per cent) of the cases in which specimens were removed for biopsy. In the inoperable group thirty-six of the patients underwent bronchoscopic examinations and the malignant lesion was thought to be present in all of them. In two cases biopsy was not performed and in three cases only inflammatory reaction was found in the tissue removed for biopsy. Microscopic study revealed the presence of bronchogenic carcinoma in thirty-one (91 per cent) of the cases in the inoperable group in which specimens were removed for biopsy.

SITE OF LESION

The right side usually is reported to be involved more frequently than the left in bronchogenic carcinoma. In 4,732 cases collected from the literature by Ochsner and DeBakey, 58.3 per cent of the tumors involved the right lung and 41.6 per cent involved the left lung. A large majority of the malignant bronchial tumors begin in the region of the hilus. The bronchial distribution of the lesions in our series is indicated in Table 4.

TABLE 4—SITE OF INVOLVEMENT IN NINETY CASES

Bronchus Involved	Operable Lesion		Inoperable Lesion	
	Cases	Per cent	Cases	Per cent
Left upper	6	13	11	24
Left lower	8	18	2	5
Left main	9	20	8	18
Right upper	4	9	11	24
Right lower	13	29	6	13
Right main	5	11	7	16
Total cases	45		45	

Percentage is based on total cases in group

PATHOLOGY

It is now generally accepted that carcinoma of the lung invariably arises from the bronchial mucosa. Microscopically bronchogenic carcinomas are classified at the Clinic as being either squamous cell

TABLE 5—TYPE OF LESION AND GRADE OF MALIGNANCY

Type of Lesion	Operable Lesion			Inoperable Lesion		
	Grade of Malignancy	Cases	Per cent	Grade of Malignancy	Cases	Per cent
Adenocarcinoma	1	7	16	1	2	4
	2	5	11	2	2	4
	3	5	11	3	4	9
	4	2	4	4	14	31
Squamous cell epithelioma	2	2	4	2	1	2
	3	16	36	3	8	18
	4	8	18	4	14	31
Total cases		45			45	

On the basis of 1 to 4 (Broders' method)
 † Percentage is based on total cases in group

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DIAGNOSIS

Numerous aids have been proposed to assist in the diagnosis of pulmonary carcinoma. Roentgenographic and bronchoscopic examinations combined with microscopic study of specimens of tissue taken from the primary lesions are the most important diagnostic methods. In the operable group in this series the presence of the lesion was suspected at the time of the roentgenographic examination in thirty-six cases (80 per cent) and unsuspected in nine cases (20 per cent). In the inoperable group the lesion was thought to be present in forty-two cases (93 per cent) and unsuspected in three cases (7 per cent).

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SITE OF LESION

The right side usually is reported to be involved more frequently than the left in bronchogenic carcinoma. In 473 cases collected from the literature by Ochsner and DeBiley, 58.3 per cent of the tumors involved the right lung and 41.6 per cent involved the left lung. A large majority of the malignant bronchial tumors begin in the region of the hilus. The bronchial distribution of the lesions in our series is indicated in Table 4.

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Total cases	45		45	

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	Grade of Malignancy	Cases	Per cent†	Grade of Malignancy	Cases	Per cent†
Adenocarcinoma	1	7	16	1	2	4
	2	5	11	2	2	4
	3	5	11	3	4	9
	4	2	4	4	14	31
Squamous cell epithelioma	2	2	4	2	1	2
	3	16	36	3	8	18
	4	8	18	4	14	31
Total cases		45			45	

On the basis of 1 to 4 (Broders' method)

† Percentage is based on total cases in group

epithelioma adenocarcinoma or mixed tumor with characteristics of both of the previously mentioned types. Bronchogenic carcinoma generally is of a high grade of malignancy. Squamous cell epithelioma occurs slightly more frequently than do the other types and is generally thought to be the type best suited for surgical removal. The lower incidence of metastasis and less rapid growth of the tumor favor surgical extirpation. A summary of the observations made on the pathology of the lesions encountered in our series follows. In the operable group eighteen patients (40 per cent) had an adenocarcinomatous type of lesion, twenty six (58 per cent) had squamous cell epitheliomas and one patient (2 per cent) had a mixed tumor. In the inoperable group twenty two patients (49 per cent) had adenocarcinoma and twenty three (51 per cent) squamous cell epithelioma. The different grades of malignancy of the lesions are shown in Table 5.

METASTASIS

Metastasis from bronchogenic carcinoma may occur in four ways: (1) by direct extension, (2) through the lymphatics, (3) through the blood stream and (4) by bronchial embolism. This last method has been used as an explanation for the peripheral involvement of the lung in those cases in which the primary lesion originates proximally. The regional lymph nodes and the bronchial nodes are the most frequent sites of metastatic lesions. In most reported series these nodes are involved in practically all the cases of carcinoma of the bronchus. The liver is the next most frequent site of metastatic lesions and is involved in approximately 30 to 40 per cent of the cases which come to necropsy. The next most frequent sites of involvement are as follows: bone, adrenal glands, kidneys and brain.

TREATMENT

Preoperative Measures.—In our cases every effort was made to improve the general condition of the patient as much as possible before operation. In cases in which suppurative disease of the lung was secondary to the malignant lesion obstructing the bronchus, bronchoscopic aspiration was performed as often as necessary in order to remove as much of the infected secretions as possible.

Relatively recently the oral administration of one of the sulfonamide compounds has been added to the preoperative preparation of the patient as a precaution against infectious postoperative complications. Of the cases in which pneumonectomy was performed in our series sulfathiazole was used in three cases, sulfanilamide was used in one case and sulfadiazine was administered in nineteen cases.

Anesthesia.—Differences of opinion have been expressed concerning the preferable anesthetic for pneumonectomy. Local spinal and in

halation anesthesia all have been suggested. Most surgeons in this country seem to prefer cyclopropane inhalation anesthesia administered under positive pressure. Some objections have been made to the use of the intratracheal tube because increased secretion results from the trauma produced by the tube. This in turn increases the possibility of infection. However the intratracheal tube for administration of cyclopropane for pneumonectomy with frequent aspirations of any mucus that might collect in the trachea or bronchi is the method generally preferred at the Clinic. In forty three of the cases in the operable group in our series cyclopropane was used and in two nitrous oxide oxygen and ether. There were no known complications from the anesthesia.

Operative Procedures—Methods of approach for pneumonectomy differ. Some surgeons prefer the posterior approach of Crafoord, some the anterior approach of Rienhoff, and others favor various modifications of these two methods. At the Clinic the posterolateral approach usually is preferred. The posterolateral type of incision was used in thirty nine (87 per cent) of the forty five cases in the operable group and the anterior approach in six cases (13 per cent).

Total pneumonectomy with complete removal of the mediastinal lymph nodes was performed in forty three cases. In the other two cases the presence of the carcinoma of the bronchus was not known preoperatively and was discovered only after lobectomy had been performed because of extensive bronchiectasis. The general condition of the patient at that time did not warrant further surgical extirpation.

Complications and Results—In fourteen cases (31 per cent) in the operable group empyema developed after pneumonectomy. The incidence of empyema after pneumonectomy has been much smaller since prophylactic use of the sulfonamides was started.

In the series of forty three pneumonectomies and two lobectomies performed for carcinoma of the bronchus the following results were obtained. Seven (16 per cent) of the forty five patients died in the first twenty four hours after the operation. Seven additional patients (16 per cent) died in the hospital. In one case the lesion recurred in the pleura nine months after operation. One patient died three months after pneumonectomy was performed. No correspondence or further examinations were obtained in four cases. All the other twenty five patients were alive and without known recurrence of the malignant lesion when last heard from or at the time of the last examination at the Clinic. The period of time that these patients had been observed without known recurrence is indicated in Table 6.

The condition of the patient after thoracotomy and surgical exploratory operation was ascertained in twenty five cases. A summary of these observations is shown in Table 7.

TABLE 6—POSTOPERATIVE PERIOD OF KNOWN FREEDOM FROM RECURRENCE IN TWENTY FIVE CASES IN WHICH THE LESION WAS REMOVED

Free of Recurrence mos	Cases	
	Number	Per cent
1 to 6	9	36
7 to 12	6	24
13 to 18	5	20
19 to 24	1	4
25 to 30	3	12
31 to 48	1	4

TABLE 7—BRONCHOGENIC CARCINOMA RESULTS IN TWENTY FIVE CASES IN WHICH THE LESION WAS INOPERABLE

Condition of Patient	Period after Operation mos	Cases	
		Number	Per cent
Alive	5	2	8
Alive	14	1	4
Dead	1 to 6	13	52
Dead	7 to 12	6	24
Dead	13 to 18	2	8
Dead	26	1	4

COMMENT

Ninety cases of carcinoma of the bronchus that were selected for surgical treatment at the Clinic from January 1, 1935 to about October 1, 1943, were studied. In forty-five cases (50 per cent) the lesions were considered operable. Total pneumonectomy was performed in forty-three cases and resection of the involved lobe in two. Cyclopropane inhalation anesthesia administered through an intratracheal tube was the anesthetic of choice. The posterolateral approach usually was preferred because it was thought that this exposure permitted less difficult mobilization of the lung and better access to the hilar structure.

Empyema developed in fourteen (31 per cent) of the cases in which resection or pneumonectomy was carried out. Now that the sulfonamide preparations are used in the preoperative preparation of the patient, are applied intrapleurally at the time of operation and are used in the postoperative care of the patient, it is hoped that this incidence of empyema may be reduced greatly.

Of the patients who were treated surgically, seven (16 per cent) died within twenty-four hours after operation and an additional seven (16 per cent) died in the hospital. The only known recurrence was situated in the pleura. It appeared nine months after pneumonectomy had been performed. One patient died three months after pneumonectomy had been performed. No correspondence or further examinations were obtained in four cases. All the other patients in the operable group were alive and without known recurrence when last examined or heard from. The duration of symptoms in the inoperable group was not appreciably longer than in the operable group but the lesions in the inoperable group were in general of a higher grade of malignancy.

Further improvement in the prognosis in bronchogenic carcinoma would seem to be dependent on several factors as follows: (1) earlier diagnosis of the lesion followed as soon as possible by total pneumonectomy and complete excision of the mediastinal lymph nodes; (2) adequate prophylaxis and treatment of infectious complications with chemotherapy; (3) more frequent exploratory operations in cases in which carcinoma of the bronchus is suspected and (4) further refinements in anesthesia and surgical technique.

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PULMONARY ABSCESS

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THE PROBLEMS of pulmonary suppurative disease present a serious challenge to the medical profession. Although the treatment of these conditions should properly be carried out by specialists in thoracic medicine, bronchoscopy and thoracic surgery, the principles involved in the prevention and recognition of suppurative disease of the lung should be familiar to all physicians.

Pulmonary abscess is the most striking manifestation of pulmonary suppurative disease. Although pulmonary abscess is not encountered commonly by the general practitioner, it is extremely important that the predisposing factors and the earliest signs be recognized by him. It must be realized that pulmonary abscess is a serious disease that has a high mortality rate. Among those patients who survive the acute phases of the disease, pulmonary disability is common. The prognosis of pulmonary abscess is unfavorable except for that group of patients who receive early and adequate treatment. The therapy of simple uncomplicated abscess is relatively safe and the results are satisfactory. The management of pulmonary abscess in late stages after complications have arisen is often difficult and hazardous and the results may leave much to be desired.

It is our purpose to discuss the mechanisms involved in the production of pulmonary abscess and the obvious means at hand to prevent the disease. The early diagnosis of the condition requires alertness on the part of the physician and willingness to employ all available diagnostic aids. When the tentative diagnosis has been made, we believe that these patients should be cared for by physicians with the special training and equipment necessary for treatment. The methods of treatment will be discussed briefly without any attempt to go into technical details.

CLASSIFICATION

In beginning our discussion it is advisable to clarify our attitude with respect to the classification of pulmonary abscesses. In the past it has been customary to refer to acute, subacute or chronic pulmonary abscesses. We believe that it is more rational to divide these cases into *simple* and *complicated* abscesses, as suggested by Overholt and Rumel, or *uncomplicated* and *complicated* abscesses, as recommended by Moore. A simple pulmonary abscess may be defined as a solitary cavity in the lung without any associated bronchiectasis or pulmonary fibrosis. Simple abscesses are usually early abscesses which

are observed but a few weeks after their origin. The complicated pulmonary abscess may be multilocular and is characterized by the presence of associated bronchiectasis, pulmonary fibrosis or empyema. In general, complicated pulmonary abscesses are of longer duration than simple abscesses. It should be pointed out that complications may develop at any stage in the course of pulmonary abscess. As in any other disease, the presence of complications makes treatment infinitely more difficult and much less satisfactory than treatment of the uncomplicated condition. It is important in evaluating the prognosis and in determining the treatment of choice that complications of pulmonary abscesses be recognized. Adequate roentgenographic studies and bronchograms are often of great assistance in the recognition of complicated pulmonary abscess.

Attempts have also been made to classify pulmonary abscesses according to the character of the sputum. When the sputum has a foul odor, abscesses have been designated as *putrid* or *fetid*. When no odor is present, the abscesses have been called *nonputrid* or *nonfetid*. Such terms are but a reflection of the bacteriologic character of abscess. Anaerobic or tissue destroying organisms produce fetid sputum. In general, fetid or putrid abscesses are more fulminating and require more immediate treatment than the nonputrid type. It has been our observation that putrid abscesses tend to lose their foul odor when satisfactory endobronchial or external drainage has been established. Adequate aeration does not favor the growth of anaerobic organisms. Similarly, when patients survive the acute phase of putrid pulmonary abscess and chronic abscesses develop, the sputum frequently becomes less putrid than before. However, in these same cases, complicated abscesses which may be multilocular with thick fibrotic walls and associated bronchiectasis also develop. It is apparent, therefore, that the classification into putrid and nonputrid abscesses is less significant than the classification into simple and complicated abscesses.

ETIOLOGY AND PATHOGENESIS

In discussing etiology and pathogenesis, we must consider certain basic factors that enter into the production of pulmonary abscesses. These factors are *infection*, *bronchial obstruction*, *disturbance of the physiologic mechanisms of the bronchi and bronchioles*, and *local ischemia of the pulmonary segment*. A brief discussion of these four factors will bring out the mechanisms concerned in the development of pulmonary abscesses and should point out certain obvious means of preventing them.

Bacterial organisms are present in all pulmonary abscesses. The bacterial flora is always mixed, but it has been demonstrated that anaerobic organisms are present in 80 per cent of cases. Although septic emboli

lodging in the lung are undoubtedly the cause of some pulmonary abscesses it is generally agreed that most abscesses are caused by aspiration of bacteria from the mouth and nasopharynx. Septic conditions of the mouth and upper part of the respiratory tract are known to predispose to pulmonary abscess. Certain circumstances may favor the aspiration of infected oronasal secretions into the bronchial tree. Thus pulmonary abscesses occur commonly after tonsillectomy, dental extractions and other operations on the upper part of the respiratory tract especially if these operations are performed with the patient under general anesthesia. Aspiration of oronasal secretions into the bronchial tree may occur during any period of unconsciousness including the general anesthesia of surgical operations, coma precipitated by trauma, drowning, epilepsy, drug poisoning, syncope and even acute alcoholism.

Bronchial obstruction may be an important factor in the causation of pulmonary abscesses because aspirated secretions are thus retained in the pulmonary segment. Bronchial obstruction may be caused by foreign bodies, bronchial tumors, external bronchial compression and especially by the so called mucous plug. Aspirated oronasal secretions may become viscous and difficult to expel. Retained bacteria multiply and rapidly invade the bronchial wall and peribronchial structures. Atelectasis favors the growth of anaerobic organisms which possess a marked necrotizing property.

Physiologically normal bronchi and bronchioles possess a remarkably efficient mechanism for expelling noxious substances. The cough reflex, ciliary activity and bronchial and bronchiolar contractions are capable of expelling almost any foreign material under normal circumstances. When the cough reflex is subdued by anesthesia, coma or sedation retention of aspirated secretions and other material is favored. Ciliary activity and bronchial contractility are practically absent in chronic pulmonary disease such as bronchiectasis or pulmonary fibrosis. The normal elastic tissue in such bronchi has been destroyed. It is believed that a state of vasomotor paralysis exists in the pulmonary segment affected by pneumonia or pulmonary infarction. Bronchial and bronchiolar activity is greatly restricted. Aspirated material from the upper part of the respiratory tract is retained and if organisms of necrotizing character are present pulmonary abscess may develop.

Local ischemia of the pulmonary segment is a necessary factor in the development of pulmonary abscess. Pulmonary emboli, both of the septic and of the bland type, are known to cause a certain percentage of pulmonary abscesses. The necrosis of pulmonary tissue produced by the embolus may result in the formation of an abscess especially if necrotizing bacteria are present. It is believed that pulmonary infarction likewise occurs in the aspiratory type of abscess. As Betts has

pointed out the blood supply of the lung is closely related anatomically to the bronchial distribution. As has already been mentioned the spread of infection incident to bronchial obstruction and atelectasis involves both the bronchial and the peribronchial structures. The result is impairment of the blood supply to the pulmonary segment and necrosis of pulmonary tissue. Necrosis begins in the periphery of the pulmonary segment and for this reason nearly all pulmonary abscesses are located in the peripheral portions of the affected lobe.

From the foregoing considerations it seems reasonable to postulate that except for those instances in which pulmonary abscess is embolic in origin the chief factor in the production of the disease is infection in the mouth and upper part of the respiratory tract. The best prophylaxis against pulmonary abscess is the correction of oronasal sepsis. If possible tonsillectomy, dental extractions, operations on the nasal cavity or paranasal sinuses and so forth should be done with the patient under local anesthesia. Attention should be paid to the state of the mouth before surgical operations are performed. Unnecessary opiates should not be administered postoperatively to the patient. Bronchoscopic aspiration should be employed if patients are suspected of having retained bronchial secretions, atelectasis or persistent pulmonary infiltrates.

The expression unresolved pneumonia has no place in medical terminology. When pneumonic processes fail to resolve it usually means that bronchial obstruction is present, that necrosis of pulmonary tissue has developed or that there is associated empyema. In such cases the nature of the complication usually can be ascertained by careful physical examination and roentgenographic studies of the thoracic cavity. When empyema is suspected thoracocentesis should be done. In other cases of so called unresolved pneumonia bronchoscopy should be performed. Fairly frequently bronchial stricture accompanies pneumonia. Bronchial obstruction can often be relieved by bronchoscopic means. We believe that many patients suffering from acute pulmonic disease may be spared serious pulmonary suppurative complications if timely bronchoscopic examination is carried out.

DIAGNOSIS

The diagnosis of pulmonary abscess should not present any difficulty except in the early stages of the disease. *Fever, cough* and *dyspnea* in the postoperative period should make the physician suspicious of a pulmonary complication. If the pulmonary lesion fails to resolve after the usual measures have been taken pulmonary abscess should be suspected. Similarly one should suspect pulmonary suppuration when pneumonia fails to resolve in the customary fashion. Recognition of

an impending pulmonary suppurative process is very important at this stage because it is often possible to abort the process by bronchoscopic intervention. In the early phase of pulmonary abscess there is frequently no communication of the abscess with the bronchial tree. The temperature may be persistently elevated and the cough dry and very irritating. When the abscess ruptures into the bronchus the diagnosis is usually unmistakable. The cough becomes productive of purulent sputum usually in large amounts and having a fetid or putrid odor. The temperature becomes of the type characteristic of sepsis with a daily rise and fall corresponding to the filling and emptying of the cavity. When the bronchial communication is established the patient becomes more comfortable although he may be distressed by periodic episodes of coughing with expectoration of large amounts of foul sputum.

In the early phase of the disease the *leukocyte count* is likely to be very high. When the abscess ruptures into the bronchus the leukocyte count usually falls. The *sedimentation rate* will be constantly elevated. In the later stages secondary *anemia* is the rule.

Roentgenographic studies are of the greatest importance in all phases of the disease. In the early stages the roentgenographic changes alone are not diagnostic as the pulmonary infiltrates will resemble the picture of pneumonia, pneumonitis, atelectasis or infarction. However, when bronchial communication has occurred a partially filled cavity may be discerned if the roentgenograms are made with the patient in the upright position. The roentgenographic findings are essential to the accurate diagnosis of pulmonary abscess. Adequate roentgenograms are of the greatest importance in localizing the abscess in relation to the thoracic wall when external surgical drainage is contemplated. Stereoscopic roentgenograms, anteroposterior, lateral and oblique roentgenograms made with the Bucky diaphragm and roentgenograms made in the lateral decubitus are all very helpful to the surgeon in the localization of the abscess. Further roentgenographic studies are required to evaluate the response to treatment. Roentgenograms should be made at regular intervals until the lesion is entirely healed. Bronchograms made with iodized oil are very necessary to detect associated bronchiectasis both before and after treatment.

Bronchoscopic examination should be considered a valuable aid in the diagnosis of pulmonary abscess. The detection of a foreign body or bronchial tumor may greatly influence the choice of treatment. At bronchoscopy it is often possible to distinguish the bronchus from which pus exudes and thus aid in the localization of the abscess. Bronchoscopic therapy may be carried out at the time of the diagnostic procedure.

COMPLICATIONS

Complications may develop at any stage in the course of pulmonary abscess. The very acute and fulminating abscess may perforate into the pleural space before the diagnosis has been made or before there has been any opportunity for treatment. Nonpyogenic pleural effusion accompanies pulmonary abscess in a small percentage of cases. Empyema may occur at any time. As we have already stated, bronchiectasis and pulmonary fibrosis are the usual accompaniments of a chronic abscess. These complications frequently develop among patients who fail to receive treatment promptly. Such patients may become chronic, hopeless invalids and ultimately succumb to pneumonia or intercurrent disease.

The tendency of pulmonary lesions to metastasize to the brain is well known. Pulmonary abscess is no exception and metastatic cerebral abscesses and meningitis are common complications. Fairly frequently such cerebral complications result when an attempt is made to carry out surgical procedures in a case in which pulmonary suppuration is far advanced and complicated. We cannot emphasize too strongly the importance of early diagnosis and early treatment of pulmonary abscess.

PROGNOSIS

Statistically it is possible to present very satisfactory therapeutic results if the cases under discussion are all of the uncomplicated type. If both simple and complicated pulmonary abscesses are included the reported results are much less favorable. Unfortunately the physician interested in thoracic diseases, the bronchoscopist and the thoracic surgeon must accept all patients suffering from pulmonary abscess that present themselves. The pulmonary abscesses that are encountered will be acute and chronic, early and late, simple and complicated, fetid and nonfetid, and of both embolic and aspirational causation.

Considering the group as a whole it is well known that 20 to 25 per cent of pulmonary abscesses will resolve spontaneously. With medical measures including postural drainage, sulfonamides and bronchoscopic treatment, satisfactory results are obtained in more than 50 per cent of all cases. The figures for surgical treatment are not much better than this when all types of pulmonary abscess are considered. However, reports on patients suffering from acute pulmonary abscess, especially of the simple or uncomplicated type in which it has been possible to treat the lesion early, indicate that treatment is very efficacious. In a series of cases in which the pulmonary abscesses were less than four weeks old, 89 per cent of the patients were cured with bronchoscopic treatment.³ Surgical results in comparable groups as reported by various authors have shown that 85 to 95 per cent of

patients were cured. It is obvious that if pulmonary abscess can be recognized early and treatment instituted before complications have developed the prognosis of this disease should be good.

TREATMENT

The treatment of pulmonary abscess is essentially the same as the treatment of an abscess in any other part of the body. The pus must be evacuated from the cavity and free drainage instituted.

The proper management of pulmonary abscess requires the closest co-operation among the internist, the bronchoscopist, the radiologist and the thoracic surgeon. The decision that external drainage of pulmonary abscess should be carried out never should be made without careful consideration. It is generally agreed that about a fourth of all pulmonary abscesses will clear up completely with conservative medical measures. In other words, in about 25 per cent of cases of pulmonary abscess the abscess will necrose its way into a bronchus large enough to permit adequate drainage and ventilation of the abscess and healing will occur. As we have already stated, it has been our experience that in at least an additional 25 per cent of the cases it is possible by bronchoscopic means to establish adequate drainage and healing of the abscess.

Since it has been our experience that about half of the pulmonary abscesses that we encounter can be treated satisfactorily without establishing external drainage by surgical means, we feel strongly that most patients should have the benefit of a trial of medical and bronchoscopic treatment before surgical treatment is instituted. Bronchoscopy should be carried out routinely, not only because many patients can be directly benefited by bronchoscopic treatment but also because the possible presence of an unsuspected foreign body or neoplasm may be ruled out by this means. It is true, of course, that many abscesses are situated far peripherally or are in locations obviously not suitable for bronchoscopic treatment but even in these cases important information regarding the location of the abscess can be gained by bronchoscopic identification of the bronchus leading to the abscess. Bronchoscopic treatment should never be persisted in if the lesion is situated in a part of the lung inaccessible to bronchoscopic treatment or for patients who do not respond promptly to this treatment but as yet we have not had any reason to regret our policy of performing bronchoscopy at least once in all cases of pulmonary abscess.

Medical Measures.—Specific medical measures are directed toward the improvement of free endobronchial drainage. Unless a communication exists between the abscess and the bronchial tree, medical treatment is doomed to failure. Frequent use of postural drainage exercises enlists the help of gravity in emptying pus from the cavity into the

bronchial tree. Medications such as iodides or guaiacol, whether given by oral, parenteral or intratracheal means, are of value only if they are successful in thinning out the thick secretions of the abscess. Inhalations of steam may be equally valuable in this regard. Arsenical compounds have been employed because of their effect on the spirochetal organisms that frequently are found in pulmonary abscess.

Sulfonamide compounds may prove helpful in the treatment of pneumonitis associated with pulmonary abscess but probably have little effect on the abscess itself. The intratracheal administration of sulfonamide compounds has been tried with some apparent success and may prove to be a valuable adjunct to drainage methods. At present sulfonamide compounds appear to be most valuable in the preoperative preparation of the patient. We have not had any experience with the use of solutions of alcohol for intravenous administration but their use does not seem rational. Antibiotic preparations such as penicillin may prove to be of value in the very early phase of the disease.

Bronchoscopy—We feel that bronchoscopy plays an important part in the treatment of pulmonary abscess. By bronchoscopic means it is frequently possible to establish adequate endobronchial drainage and provide for successful medical treatment. Stenosis of the bronchus which communicates with the pulmonary abscess commonly occurs. With dilating forceps the stenotic bronchus can be opened and free drainage of the abscess instituted. In many instances it is possible to pass the aspirating tube directly into the abscess cavity and evacuate the contents. More adequate aeration of the abscess cavity is also provided by this means. Because of the high incidence of anaerobic organisms in pulmonary abscesses, this fact is of importance.

Bronchoscopic aspiration and external surgical drainage should not be considered as competitive methods of treatment for pulmonary abscess. We feel that nearly all patients suffering from pulmonary abscess, including those whose abscesses are acute, should have a brief period of medical management. Bronchoscopy is invariably done even if for diagnostic reasons only. The surgeon is asked to see the patient at the time of admission to the hospital. If after a few days of medical management and one or two bronchoscopic aspirations there is not definite evidence of improvement, both clinical and roentgenographic, surgical treatment is given immediate consideration. Bronchoscopy is also very valuable in the preoperative and postoperative phase of the surgical treatment. The aspiration of secretions from the bronchial tree before, during and after surgical treatment is imperative in many cases.

Surgical Treatment—Pneumothorax, interruption of the phrenic nerve or thoracoplasty should not be used in treatment of pulmonary abscess. These procedures are used effectively in the treatment of tu-

berculous cavitation but a pulmonary abscess presents a far different type of problem. The fundamental principle of treatment of pulmonary abscess is the establishment of adequate drainage and adequate ventilation of the abscess cavity. Pneumothorax, interruption of the phrenic nerve and thoracoplasty accomplish nothing in this respect; they only hinder. Interruption of the phrenic nerve interferes with the cough mechanism which is essential for the evacuation of the abscess. Thoracoplasty is a mutilating operation which unnecessarily collapses a large portion of healthy lung without contributing anything toward more adequate drainage. Pneumothorax is not only useless but also extremely dangerous since by collapsing the lung and pulling the lung away from the thoracic wall it may cause the abscess to rupture and produce total putrid empyema.

Surgical treatment of an abscess should not be carried out without due consideration not only of the fact that half of all pulmonary abscesses can be cured by more conservative measures but also of the fact that the patient is being submitted to a procedure which carries a definite risk and entails a considerable period of pain, disability and expense before the wound is completely healed. It is true that these considerations are small as compared with the danger of allowing a simple abscess to become a complicated abscess but to the patient they are important. As soon as it is obvious that a pulmonary abscess is not amenable to conservative measures—and often this is only a matter of two or three days—surgical treatment should be advised and carried out promptly. The type of surgical treatment that is carried out depends not on the chronologic age of an abscess but on the question whether it is a simple or a complicated abscess.

A simple uncomplicated abscess which does not respond promptly to conservative measures as evidenced chiefly by frequent roentgenographic studies of the lesion, should be drained externally as soon as possible in order to prevent bronchiectasis, pulmonary fibrosis, gangrenous pneumonia or empyema which are likely to develop as complications of an inadequately drained and ventilated abscess. As Neuhof and Touroff, Overholt and Rumel and others have pointed out, pulmonary abscesses usually are situated in the periphery of the involved lobe and in most instances they are adjacent to the thoracic wall at some point. These authors also have demonstrated that in almost every instance inflammatory adhesions will have developed between the lung over the abscess and the thoracic wall to produce a pleural symphysis in the region of the abscess that permits a one stage operation to drain the abscess provided the abscess is accurately located. Accurate location of the abscess before operation is essential to success of surgical treatment of uncomplicated pulmonary abscess. This accurate localization can be accomplished by means of accurate roent-

genologic studies of the abscess in both the anteroposterior and the lateral view. Rabin and Overholt and Rumel have developed even more accurate methods of localization by studying the abscesses roentgenoscopically and injecting mixtures of methylene blue or lampblack in radiopaque oil in the interspace overlying the abscess under roentgenoscopy. The position of the spot of radiopaque oil in relation to the abscess can be checked by further roentgenograms of the thoracic cavity and the dye in the tissues is an accurate guide for the surgeon at the time of operation.

It is not necessary here to go into all the technical details of the operation. These have been described thoroughly in the literature.^{5, 6} It should be mentioned that these operations are best performed with the patient under local anesthesia in order that the cough reflex be not interfered with during the operation. A diagnostic aspiration should never be carried out for pulmonary abscess until the thoracic wall has been opened down to the parietal pleura and the presence of adhesions between the lung and the thoracic wall has been definitely established. The abscess should be opened with a cautery and the cavity opened sufficiently to permit evacuation of the necrotic debris and pus from the cavity and to maintain adequate drainage and ventilation of the cavity. If the abscess has been located accurately and the operation is carried out properly, there is little danger of opening into the free pleura around the abscess and producing empyema. Two stage operations are necessary only when the abscess is inaccurately localized or when the abscess presents along an interlobar fissure, the diaphragm or the mediastinum.

In cases of pulmonary abscess complicated by the development of bronchiectasis, pulmonary fibrosis, empyema and so forth, simple drainage of the abscess is not usually sufficient. Empyema resulting from a pulmonary abscess is an extremely serious complication since it is a foul, putrid type of empyema. Open drainage of the empyema must be established as soon as possible.

Bronchiectasis and pulmonary fibrosis are serious complications since they are manifestations of permanent changes in the lung and persist even if the primary abscess is drained satisfactorily. There is a growing conviction among those particularly interested in this problem that in these cases of chronic pulmonary abscess complicated by bronchiectasis and pulmonary fibrosis the condition is best treated by pulmonary lobectomy or pneumonectomy. The operations are often difficult and the risk is considerable but the pathologic changes in these lungs are irreversible and unless the damaged tissue is removed these patients continue to suffer from chronic pulmonary suppuration and are permanent lung cripples. Lindskog, Sweet and others have performed pulmonary resections successfully in a number of such cases.

CONCLUSIONS

The following conclusions are drawn

1 Simple pulmonary abscesses should be distinguished from those abscesses which are complicated by bronchiectasis pulmonary fibrosis or empyema or by more than one of these conditions

2 Aspiration of infected oronasal secretions is the most important factor in the production of pulmonary abscesses In many instances it should be possible to prevent pulmonary abscess

3 The early diagnosis of pulmonary abscess is sometimes difficult and requires all available diagnostic aids Roentgenoscopic study is the most valuable method in diagnosis and localization of pulmonary abscess and is essential to the evaluation of treatment

4 Bronchoscopic examination is desirable in all cases of pulmonary abscess for diagnostic and frequently for therapeutic reasons

5 The object of treatment of pulmonary abscess is to provide adequate drainage before complications have developed Such drainage may be endobronchial or external

6 Endobronchial drainage will occur spontaneously in about 20 to 25 per cent of all cases Endobronchial drainage can often be greatly improved by bronchoscopic means When bronchoscopic aspiration is combined with postural drainage and other medical measures more than half of all pulmonary abscesses may be managed satisfactorily without surgical intervention Such medical management may be carried out without jeopardizing the patient's chances for successful surgical treatment.

7 External drainage by surgical means is a very satisfactory method of treating uncomplicated pulmonary abscess It should be employed in all cases in which the response to medical management and bronchoscopic therapy is not prompt and adequate

8 The treatment of pulmonary abscess must necessarily remain the province of specialists in thoracic medicine and surgery Unfortunately many patients suffering from pulmonary abscess progress to a chronic and complicated stage before active therapy is undertaken Complicated abscesses do not respond well to either medical or surgical treatment

9 In selected cases of complicated pulmonary abscess pulmonary lobectomy or pneumonectomy is indicated

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TRAUMATIC INJURIES OF THE ABDOMEN

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THE MAJORITY of reports of abdominal injuries have come from cities where such cases are encountered in sufficient numbers to warrant special study. It occurred to us that a review of the cases encountered at the Clinic might reveal differences from similar cases encountered in cities as to the type of trauma, the time between injury and treatment or the outcome of the case, since the area surrounding the Clinic is essentially rural and accidents, at least those that occurred during the earlier years covered by the report, were those of the farm and countryside as opposed to those occurring in cities and in industry.

It is evident that a patient injured in a city probably will get treatment sooner than one injured in a rural community. Different types of trauma would be expected. The gunshot wounds observed at the Clinic were the result mostly of bullets of small caliber and low velocity and since the shootings were mostly accidental, the majority of the patients were shot only once. In recent years an increasing number of patients who had been in automobile accidents have been treated and it would appear that highway accidents in the country occur at higher speeds with consequently more serious injuries than automobile accidents in cities. The patients seen here were treated by comparatively few surgeons and the methods of treatment used were perhaps less varied than when a larger number of surgeons were working. Finally, as would be expected, the characteristically rural injuries, for example, impalement of the rectum, made up a relatively large proportion of the cases.

The material for this report was assembled from the records of cases and necropsy reports of patients suffering from traumatic abdominal injuries seen at the Clinic from 1910 to 1939 inclusive. Since in this period what now would be considered adequate chemotherapy was not yet available, it will be of interest to compare this series with a similar number handled in the future with the aid of chemotherapeutic agents. The only patients included who had injuries to the urinary system were those who had other abdominal injuries as well, since Priestley and Pilcher³⁷ have reported recently the data on cases of subcutaneous rupture of the kidney observed at the Clinic and the inclusion of these cases would lead to duplication. The diagnosis and the extent of the visceral damage in most cases were verified either at operation or at necropsy. In all cases included in this paper in which the diagnosis was not verified at operation or at necropsy the clinical

diagnosis seemed certain enough to warrant their inclusion. All patients for whom the diagnosis was doubtful or incomplete were excluded as were patients who died before diagnosis or treatment could be attempted. Eighty-two patients were studied in all. Thirty-four had penetrating injuries and forty-eight had nonpenetrating injuries of the abdomen. One of the forty-eight patients had injuries to his duodenum, liver and spleen.

It is our plan to deal only briefly with the penetrating injuries because of the small series and because several excellent reports have appeared recently. A sufficiently large series of nonpenetrating injuries were treated to warrant a more extensive review than that of the penetrating injuries.

PENETRATING INJURIES

While there are references in the literature to the enlarging of abdominal wounds and to the repair of visceral injury as early as 1525 there were few such attempts at operative treatment until the development of anesthesia and asepsis. Sims³⁰ in 1882 predicted that there was every certainty of obtaining the same success in the treatment of gunshot abdominal wounds as held for ovariectomy. He urged that when bullets had traversed the peritoneal cavity the abdomen should be explored and an attempt made to repair the damage. Such advice was accepted only gradually but the mortality rate from abdominal gunshot wounds which was 90 per cent in the Civil War had been reduced to about 75 per cent by 1900. By the later years of the War of 1914-1918 the mortality rate from gunshot wounds of the abdomen had reached 50 to 60 per cent where it had remained until recently when with the aid of chemotherapy this figure has been lowered appreciably.

It is now recognized that with certain exceptions all penetrating wounds of the abdomen should be explored as soon as the condition of the patient permits. These exceptions as listed by Meyer and Shapiro²⁹ are (1) small stab wounds of the region of the kidney, the upper part of the abdomen and the lower part of the thorax, (2) shot gun wounds produced by a gun at such a distance that the shot has had time to separate and (3) all penetrating wounds of more than thirty-six hours duration when the patient obviously is recovering.

There is evidence supporting the viewpoint that small stab wounds of the upper part of the abdomen may be treated without immediate operation. With nonpenetrating renal injuries operation is not indicated as an emergency procedure and an eventually lower mortality rate will result if patients who have such injuries are treated conservatively. This conclusion should be true also for small stab wounds of the kidney. Bleeding from the lacerated spleen usually is not brisk and Meyer and Shapiro wrote that by careful observation a so called blood

cake about the spleen may be detected in time to do splenectomy if necessary. Surgical repair of a laceration of the liver is not particularly satisfactory and the organ cannot always be sutured successfully. Wangersteen⁴ has shown on animals that if the stomach is empty wounds up to 1 cm. in length are tolerated without mortality so that under certain circumstances recovery may be expected even following small stab wounds of this organ. It is evident that operation should not be undertaken when the danger of the operation is greater than the danger of the injury and stab wounds that would require extensive abdominothoracic exploration are best treated conservatively because of this fact. Stab wounds that penetrate the peritoneal cavity may not injure viscera and Martin⁸ failed to find visceral injury in thirty one of the fifty seven cases of stab wounds in his series.

However the slight morbidity and the negligible mortality rate associated with the surgical exploration of small stab wounds convince us that in general exploration is indicated when such wounds involve primarily the upper part of the abdomen. The two patients who had such injuries treated at the Clinic serve to illustrate this point. Both had stab wounds of the epigastrium one produced by a penknife and the other by a pitchfork. One patient did not have any evidence of peritoneal irritation and the other had moderate tenderness and slight rigidity about the injured region. In both cases exploration was performed and no visceral injury was found. One patient left the hospital on the seventh day after operation and the other on the twelfth day. It was hoped that the peritoneoscope might be of help but outside of revealing penetration of the peritoneal cavity and hemorrhage its use is very limited as it cannot be relied upon for exploration of the hollow viscera to rule out perforation. After considerable experience with the peritoneoscope one of us (Vaughn) has found that only when positive findings are visualized can it be relied on. Negative results of exploration with the instrument are unreliable in an appreciable percentage of cases.

The other exceptions to the rule of early exploration have become well established. Cases reported by Willis⁴³ and others have demonstrated that the many small visceral wounds produced by bird shot fired from sufficient range for the shot to have had time to separate defy surgical repair as a rule and that patients who have such wounds may recover with expectant treatment. Counseller and Scott¹⁰ and others have emphasized that surgical intervention following gunshot wounds is usually meddlesome when considerable time has elapsed and when the patient is obviously recovering. Such a patient should be observed for the development of localized abscesses secondary hemorrhage or perforation and treated for these complications when they develop.

The fact that bullets follow a straight course in the body is of con

siderable importance in the surgical exploration of gunshot wounds of the abdomen. As early as 1916 military observers had noted that the high velocity bullets of military rifles almost invariably followed a predictable course after striking the body and it was soon evident that the slower bullets usually causing peacetime injuries likewise followed a straight course. Oberhelman and Le Count³¹ reported that the paths of only a few of the bullets in their series were unusual and they gave details of only two cases in the entire series in which the bullets followed an apparently erratic path in the body. Others have reported the transport of bullets in large blood vessels. The straight line rule however is of less value when there is no wound of exit since a spent bullet may fall away from its previous course. Because of this fact the position of a retained bullet as shown on a roentgenogram should be used with caution to predict the viscera injured. In the present series of twenty cases of abdominal gunshot wounds there were two cases in which a bullet was retained.

One patient had been shot twice in the upper part of the abdomen from close range with a .32-caliber pistol both bullets entering the pigtail. There was one wound of exit situated posteriorly at the level of the ninth rib on the left. A roentgenogram of the abdomen showed one bullet in the pelvic region. At operation one hour after the injury two wounds in the anterior wall and one wound in the posterior wall of the stomach were repaired and other injuries to the liver, pancreas and lower lobe of the left lung were found. Death from shock and hemorrhage occurred two hours after the operation. There were no discovered visceral injuries at necropsy and one bullet was found lying entirely free on the pelvic peritoneum.

The other patient had been shot accidentally at an unknown range with a .22 caliber rifle the bullet entering the lower part of the abdomen about midway between the symphysis and the umbilicus. At operation wounds of the ileum and a laceration of the peritonealized surface of the bladder were found. The bullet was found lying free in the bladder. The wounds were sutured and the patient made an uneventful recovery.

No cases were observed of an erratic course of a bullet in the body or of the bullet being deflected from its course by anatomic structures that it encountered. It is well to remember that visceral injuries secondary to bullet wounds usually result in the total number of perforations being a multiple of two because of the almost invariable presence of a wound of entrance and a wound of exit for each bullet.

Prognosis in penetrating wounds of the abdomen depends on the extent and type of the visceral damage, on the time between injury and treatment, on the amount of hemorrhage and finally on the skill of the surgeon. The extensive data of Oberhelman and Le Count show the importance of most of these factors and from their figures the first factor would seem to have the most bearing on the outcome of

the case. In a review of data on a series of cases in which gunshot wounds were treated without the aid of blood transfusions Loria⁴ concluded that Loss of blood undoubtedly is the most influential factor concerned in the outcome of abdominal gunshot injuries. Prey and Foster³⁵ found that an average of 1.88 hours had elapsed between the time of the accident and treatment for their patients who recovered but an average of 3.4 hours had elapsed for the patients that died.

The present series of cases of penetrating injuries of the abdomen is too small to admit of statistical treatment but the most important factor from the standpoint of prognosis appeared to be the visceral damage that the patient had sustained. It would seem too that the great difference in the mortality rate between gunshot and stab wounds depended chiefly on the more extensive wounds produced by bullets.

TABLE 1—TYPE OF INJURY—PENETRATING INJURIES

Type of Injury	Patients	Deaths
Gunshot wounds	20	8
Impalement of rectum	7	2
Stab wounds	4	0
Dynamite caps	2	2
Shotgun wounds	1	1
Total	34	13

The time factor seemed of less importance than the extent of visceral damage since there was no essential difference in the average elapsed time between injury and treatment for those that recovered and for those that did not. However the average time for the group as a whole was greater than that usually reported in series of this type. Thus Martin²⁸ reported an average time of three hours and McGowan an average of 3.6 hours between injury and treatment while the average for the present series was approximately five hours. Loss of blood seemed less important than the extent of visceral injury but transfusions were used freely before, during and after operations so that the evaluation of loss of blood as a factor in the mortality rate was confused. However if clinical shock that does not respond rapidly to treatment is assumed to mean hemorrhage then hemorrhage had a very important bearing on the outcome of the cases. Thus two of the three patients who died from penetrating ileal injuries were in clinical shock when first seen while none of the three patients who recovered were in shock.

Tables 1 and 2 summarize data on the cases of penetrating abdominal injury encountered at the Clinic. The slightly decreased mortality rate as compared with similar statistics from urban areas associated with gunshot injuries may be explained partially by the fact that most of the patients were shot only once and with small caliber weapons. In Table 2 the number of viscera injured shows clearly that multiple injuries are the rule particularly with gunshot wounds which form the majority of the injuries in the series.

TABLE 2 —VISCERA INJURED—PENETRATING INJURIES

Viscera Injured	Patients	Deaths
Colon & Sigmoid	12	4
Stomach	10	5
Liver	9	6
Ileum	6	3
Jejunum	4	2
Bladder	3	0
Pancreas	3	2
Lung	3	2
Kidney		1
Spleen	2	1
Pericardium	1	1
Total	55	27

Thirty-four patients in this series had multiple injuries. Multiple injuries are the rule with gunshot wounds.

RECTAL IMPALEMENTS

Rectal impalements differ sufficiently from the usual penetrating injuries to warrant separate discussion. The mortality rate is higher than with other stab wounds principally owing to the fact that extensive peritoneal contamination is the rule and also because the treatment of such wounds is more difficult than that of the usual stab wounds. Impalements of the rectum fall into two distinct groups: the primary, in which the impaling instrument enters the rectum through the anus and the secondary, in which the perineum is pierced first and the rectum is entered secondarily and not through the anus. The secondary type usually implies a sharp impaling instrument.

Rectal impalement is not particularly rare and Clagett⁸ estimated that probably more than 700 cases have been reported. The objects reported to have caused the injury include pitchforks, picket fences, mop handles, the horns of animals and many others. Habegger¹⁹ reported that the accident occurred more often to farmers than to any other occupational group. Clagett pointed out that the funnel shaped conformation of the tissues surrounding the anus tends to direct blunt objects impinging in the area into the rectum.

Powers and O'Meara³⁴ proposed that the patients be divided into two groups. In the first are those without injury to the peritoneum and in the second are those with penetration of the peritoneal cavity. According to Habegger, the mortality rate in the first group is 7 to 8 per cent. When the peritoneum was penetrated but no organs were injured, the mortality rate rose to 25 per cent and when organs were injured intraperitoneally, the mortality rate rose to 78.57 per cent.

The diagnosis of rectal impalement is suggested by the history and by the finding of ecchymoses about the anus or lacerations of the perineum. The most common perforation is within 10 cm. of the anus so that the laceration can be palpated usually. Proctoscopic examination may be made to determine whether there are higher lacerations but bleeding and the difficulty of distending the lacerated rectum make the procedure unsatisfactory. The signs of peritoneal irritation in such cases may be slight or delayed. By analogy with other injuries to hollow viscera, gas should be present under the diaphragm in a certain percentage of the cases and a plain roentgenogram of the abdomen with the patient upright or in left decubitus should be of value. Routine urinalysis is of importance since the bladder is often injured. Shock is usually slight or absent providing the patient is seen soon after the accident.

The seven patients suffering from peritoneal penetration in the present series were all male and ranged in age from thirteen to forty-eight years. All of the injuries were produced by pitchfork handles. In all cases the injury was produced by the patient either sliding down a haystack on the fork handle or jumping backward on an upright fork handle. Five of the seven patients were brought promptly to the hospital, the serious nature of the injury being recognized immediately, but two were not seen until seven and nine hours respectively had elapsed.

All patients had perianal ecchymoses or lacerations or the rectal lesions were palpable. Five patients had tenderness and rigidity in the lower part of the abdomen. One of the five patients in this group stated that his abdomen had not become tender until three hours after the injury. The other two patients seen two and seven hours after injury had no abdominal pain and slight or no tenderness. Proctoscopic examination was not used as a diagnostic procedure nor were

roentgenograms of the abdomen taken. The diagnosis in all cases was rectal impalement with probable peritoneal penetration. The average time between injury and treatment was 4.4 hours and in five cases the patients were treated within four hours.

Because of the direction of the anal canal the laceration is most often in the anterior rectal wall and the viscera apart from the rectum most commonly injured are the bladder, ureters and small bowel. The anterior rectal wall was lacerated in all cases encountered here; in one case the laceration extended to the left rectal wall and in one case there was a second rent in the posterior rectal wall about 5 cm. above the rent in the anterior wall.

As with most other penetrating abdominal injuries exploration is indicated as soon as the diagnosis is made and the condition of the patient permits. The identification of the rectal laceration from the inside of the abdomen may be difficult and Clagett wrote that the insertion of a large rectal tube from below makes the recognition of the laceration more certain. The laceration should be closed over the tube with sutures and the tube advanced from below beyond the suture line. It is usually possible to avoid temporary colostomy when this is done and when the closure of the rectum has been satisfactory. When the closure has been difficult or unsatisfactory temporary colostomy is usually indicated and when a perineorectal laceration is present temporary colostomy is performed to guard against the development of a perineorectal fistula. Rents of the bladder are closed by sutures and either transurethral or suprapubic drainage is instituted depending on the extent of the vesical damage. A prophylactic dose of antitoxin for gas gangrene and tetanus should always be given and 10 gm. of sulfathiazole placed intraperitoneally.

The postoperative care follows the usual routine for cases in which there is peritoneal contamination by intestinal contents and includes elevation of the head of the bed, the prohibition of oral administration of fluids for several days and the use of transduodenal drainage employing the Wangenstein type of suction apparatus. After forty-eight hours of intravenous administration of sulfadiazine to maintain an adequate blood level for five to seven days after operation sulfasuxidine can be given in solution through the tube which is left clamped for a time after introduction of the sulfasuxidine.

In only one case in the present series was colostomy thought possible and advisable.

The patient, a boy of seventeen years, was seen about twelve hours after he had jumped back and from a hayrick and impaled himself on an upright pitchfork handle. He was not in shock. The abdomen was exquisitely tender and there was rigidity of both lower quadrants. The perineum was lacerated extensively and this wound communicated with a laceration of the anterior rectal wall.

Operation was undertaken as soon as possible. A moderate amount of free blood was noted when the peritoneum was opened. No intraperitoneal injuries were found but there was a large rent in the pelvic peritoneum. The opening in the peritoneum was closed with catgut sutures and a loop of sigmoid was brought out in anticipation of the possible need of making a colonic stoma. However the loop of sigmoid was not opened. The patient had a high fever after the operation with much drainage from the perineal wound but his condition improved to such an extent that the bowel was replaced on the nineteenth day after the exteriorization. The patient was dismissed from the hospital thirty days after operation and one week later a healed scar 8 cm above the anus was seen on proctoscopic examination.

In the remaining cases either a large rectal tube was used or the sphincter was dilated manually at the time of the operation.

There were two deaths among the seven patients. Both of the patients who died were seen early in the series and one of them was the only patient in the series on whom operation was not performed.

This patient a man of forty seven years of age was seen about three hours after impalement on a pitchfork handle while sliding down a haystack. There was no shock. The lower part of the abdomen was moderately tender and rigid and there was rather severe bleeding from a palpable laceration of the anterior rectal wall. The rectum was packed with gauze to control the bleeding. The general condition of the patient remained good for about forty-eight hours but at the end of this time there was a rather sudden onset of cyanosis and weakness. The patient failed rapidly and died four days after the accident. At necropsy extensive generalized peritonitis was found.

The other patient who died was a boy of thirteen years who had fallen 7 feet (2 meters) landing on the handle of an upright pitchfork, about three hours before admission to the hospital. He was in mild shock but did not present evidence of any injury other than that of the rectum. The lower part of the abdomen was markedly rigid. At operation about 400 cc of reddish, foul fluid was removed from the peritoneal cavity and perforations of the pelvic peritoneum and the anterior rectal wall were found and repaired. There was possibly an injury to the left ureter but the condition of the patient was becoming precarious and the operation was terminated. The patient continued to fail and died sixteen hours after operation. Necropsy was not done.

The complication of extensive infection about the rectum and in the ischiorectal fossa is to be expected. It occurred in three of the five cases in which the patient recovered. All three patients had high fever and much purulent drainage through and about the rectum. They remained in the hospital thirty, thirty three and fifty three days respectively after operation and none of the wounds was healed completely at the time of dismissal from the hospital. In another case in which the patient had a laceration of the bladder along with the rectal injury persistent infection of the urinary tract and epididymitis de-

veloped Of the five patients who recovered only one left the hospital in less than four weeks and without an extensively draining perineal wound

NONPENETRATING INJURIES

Nonpenetrating injuries to abdominal viscera are more common in civilian practice than are penetrating injuries and usually present more difficult problems in diagnosis There is less agreement as to the necessity for operation or the optimal time of operation and the nonpenetrating injuries are associated more frequently with other severe injuries in other regions of the body

The force causing visceral injury without penetration of the body wall may act in several ways Blows by blunt objects and crushing or squeezing are the most evident and probably the most common methods In addition, a force acting tangentially may carry an organ beyond its limits of mobility and thus cause tears in the organ Hollow viscera may be ruptured from within out by the pressure of contained fluid or gases and compressed air entering the anus may cause essentially similar ruptures Finally, spicules from fractured bones may penetrate neighboring viscera

The diagnosis often cannot be made when the patient is first seen Injuries to the thorax and spinal column may produce tenderness and rigidity of the abdominal wall and are confused easily with the signs that follow visceral injury Injured viscera may cause few or no signs at least early after the injury and localized pain tenderness spasm and vomiting may be absent In any case in which abdominal injury is possible a distinction must be made between so called peritonism and the peritoneal irritation secondary to rupture of a viscus By peritonism is meant the association of clinical shock abdominal pain and vomiting following a blow to the body wall A blow may produce this condition without injuring viscera and in many cases time only will determine whether the signs are due to visceral injury or to peritonism In the same category are injuries to the body wall alone Cullen¹¹ and others have pointed out that bleeding from the epigastric vessels below the fold of Douglas may give signs that cannot be distinguished from those of intraperitoneal bleeding since the blood lies virtually on the peritoneum More confusing from the diagnostic standpoint are the patients who present both peritonism and intra-abdominal injury Such patients may show marked improvement on conservative management and the possibility of intra-abdominal injury may be forgotten This period of the patient's relative well being has been called the period of illusion in cases of abdominal injury

Pain is the most common symptom associated with visceral injuries and some pain is present with all such injuries Pain is also associated with any blow to the body of even moderate intensity and the degree

of pain in no way parallels the degree of visceral damage. Several patients in the present series who had serious intra abdominal injury had so little pain that medical attention was not sought until complications had developed and several patients stated that no pain was noticed until several hours after the injury. On the other hand well localized abdominal pain is of considerable importance in directing attention to the viscera underlying the painful area. Much the same statement can be made concerning tenderness.

Vomiting may or may not be present and its presence does not necessarily imply visceral injury. Butler⁶ expressed the opinion that the absence of vomiting is the rule rather than the exception with visceral injury and he reported that vomiting did not appear often until after the onset of peritonitis.

The detection of free fluid and of free air in the peritoneal cavity by physical examination cannot be relied on. Fluid must be present in large amounts to be detected and shifting dullness is a late sign of little value in the diagnosis of acute injuries. A decrease of the area of percussion dullness of the liver is seldom definite but Butler found that a tympanitic area between the dullness of the liver and the resonance of the lung may be detected occasionally. Needling of the peritoneal cavity with the idea of aspirating free fluid or intestinal contents for the purpose of diagnosis has been proposed³⁰ but has not been used widely as judged by reports in the literature.

Rectal and vaginal examinations will often reveal a fracture of the pelvis and a spicule of bone may be palpated in such a position that visceral injury may be inferred. Air may be detected in the pelvic connective tissue by the characteristic crepitation. In the absence of a thoracic injury this sign indicates the rupture of a retroperitoneal air filled viscus. Finally the presence of fluid in the cul de sac may be inferred from the boggy sensation imparted to the finger.

The usual clinical laboratory procedures may give important evidence of injury. Blood in the urine indicates some injury to the urinary tract and the urine must be examined in all cases. There is little agreement in the literature as to the value of blood counts. Wright and Livingston⁴⁴ demonstrated in experimental animals the marked leukocytosis following bleeding into the peritoneal cavity. Butler and Birnbaum found definite leukocytosis in cases of hemorrhage but advised that the count should be made on venous rather than on capillary blood. More than 80 per cent of their patients suffering from ruptured spleens had more than 20 000 leukocytes in each cubic centimeter of blood. Wangenstein however stated that leukocyte counts are of little aid. There may be marked leukocytosis associated with shock and leukocyte counts are of no value in distinguishing between shock and hemorrhage.

Much recent work has been done with hematocrit, plasma, specific

gravity and plasma protein estimations in the hope that these laboratory determinations might aid in distinguishing shock secondary to hemorrhage from that secondary to trauma. Because the patient usually presents a combination of hemorrhagic and traumatic shock the determinations have not been as helpful as was hoped. Price³⁰ has stated that hemoconcentration is not reliable as a sign and measure of shock and that it is more useful as a guide to therapy than as a criterion of shock.

There is complete agreement in the literature that the use of roentgenologic examination is indispensable for the diagnosis of trauma of the abdomen. Wangenstein found that as little as 4 cc. of air will show under the diaphragm when the patient is in an upright position. Some believe the left lateral decubitus position to be superior to the upright position. Retroperitoneal hemorrhage and collections of blood about the kidney give somewhat the appearance of a perinephritic abscess and collections of blood about the spleen and free blood in the peritoneal cavity may be diagnosed earlier from the roentgenogram than on physical examination. The use of cystography and of intravenous urograms is common in the diagnosis of injuries to the urinary tract.

The presence or absence of shock is of considerable importance in the evaluation of the surgical risk and determination of prognosis. However, it should be kept in mind that the recovery from early shock is often rapid and examination of the patient on admission to the hospital may not give any evidence of his former state. Reports from localities where patients are seen soon after accidents compared with the statistics from places where some time elapses between the accident and admission to the hospital give weight to this contention. Thus Butler⁶ reported that 80 per cent of patients suffering from abdominal injury were in shock. On the other hand less than 50 per cent of the patients in the present series had evidence of shock. Recent authors have concluded that clinical shock that does not respond promptly to the usual measures of heat, rest and sedation should be considered as hemorrhage. While the academic distinction between shock and hemorrhage is of importance in practice the question is of less consequence than in theory since the treatment of the two conditions is similar.

Spleen—Guy¹⁸ estimated that the average general hospital of 200 beds will admit two or three patients suffering from rupture of the spleen each year and Butler stated that the accident is relatively uncommon. On the other hand Allen¹ found eleven cases of uncomplicated rupture of the spleen in a consecutive series of 140 cases of subcutaneous abdominal injury while Lewis and Trimble³ found seventeen cases of proved rupture of the spleen in a series of ninety-five cases of abdominal injury.

Because of its small size and the protection offered by the ribs, relatively severe trauma is necessary usually to rupture the spleen. Vance⁴⁹ concluded that the most common lesion, a transverse rupture involving the hilus, occurred when the hilar surface was rendered acutely convex in the longitudinal axis. This could be brought about by compression of the thoracic wall or by severe tangential force dragging the lower pole of the spleen beyond the lower margin of the thorax. McIndoe⁵ suggested that the lesion involving the hilus was caused by contrecoup the spleen being hurled against the vertebral column. The spleen may be lacerated by fractured ribs and, according to Vance, may be torn at its ligamentous attachments by inertia when the fall of a person is stopped suddenly. The rupture may involve both the capsule and the parenchyma or it may involve the parenchyma alone, the former condition leading to intraperitoneal hemorrhage with the usual symptoms of rupture of the spleen. Rupture of the parenchyma alone, according to Coe⁵⁰ is probably fairly common, and he suggested that the scars in the spleen seen at necropsy may have resulted from such injuries.

There is agreement that localized pain and tenderness in the left upper quadrant of the abdomen are the most constant signs of ruptured spleen. Butler and Birnbaum and McIndoe expressed the opinion that such findings are constant. Butler and Birnbaum pointed out that the pain is often distinctly cyclic. The onset of bleeding produces much pain and tenderness but with a drop of blood pressure and the formation of clots fresh bleeding stops and the pain and tenderness diminish. When the blood pressure subsequently rises and the clots become dislodged, probably as a result of a change of splenic volume, fresh bleeding starts and the more intense symptoms recur. The pain may be referred to the back or to the shoulder. Shifting abdominal dullness and a mass in the left upper quadrant are late signs and indicate considerable loss of blood.

Clinical shock probably is present in most cases in which there has been sufficient trauma to rupture the spleen. The clinical evidence of this may be slight and the shock may be transient. The shock secondary to hemorrhage from a ruptured spleen develops more slowly than that from a ruptured liver and slowly developing secondary shock when a patient is under observation after abdominal trauma should suggest rupture of the spleen.

The mortality rate of patients who have received adequate treatment depends for the most part on associated injuries and to a lesser extent on the elapsed time and the loss of blood. Of Butler and Birnbaum's five patients who died, four had associated injuries, all of Lewis and Tammes' patients who died had other serious injuries and of Gross' five patients who had associated injuries three died. Guv⁵¹ found that severe hemorrhage was always present when the laceration involved the hilus and that greater loss of blood and a higher mortality

rate followed delay in treatment. Of eleven patients admitted within eight hours of the injury two died but of nine admitted between eight and forty eight hours six died.

Twelve patients in the present series had nonpenetrating injuries to the spleen. Eight were male and four were female. The ages ranged from six to forty seven years but half of the patients were younger than twenty years. In seven cases crushing injuries to the abdomen were responsible for the damage to the spleen and blows to the left upper quadrant accounted for the remainder.

The findings on physical examination did not always suggest rupture of the spleen. In seven cases the abdominal findings pointed definitely to the left upper quadrant. All seven patients had pain and tenderness in the splenic area, three had a palpable mass and three had an area dull to percussion. Of more interest were the other five patients who presented such diffuse abdominal pain, tenderness and rigidity that no diagnosis from these findings alone could be made. Two of these patients had the recurring paroxysms of abdominal pain and tenderness that are characteristic of splenic rupture. Some degree of clinical shock was present in five of the twelve cases. The average time between injury and admission of the patients not in shock was twenty two hours while the average for the patients who were in shock was six hours.

Definite leukocytosis was present in all cases in which a white count was made and the average for the eight cases in which such counts were made was 27,650 leukocytes per cubic millimeter of blood.

Eight patients had uncomplicated ruptures of the spleen and four had associated injuries. Two patients had an associated rupture of the left kidney, one had multiple fractures of the ribs in the region of the spleen and one patient who had been run over had associated ruptures of the liver and duodenum. Two patients had definite delayed hemorrhages from lacerations of the spleen. The condition is fairly common after splenic rupture and McIndoe has reviewed the literature thoroughly. One patient did not notice any particular abdominal pain until twelve hours after his injury and the other patient continued without symptoms for forty two hours.

The treatment of rupture of the spleen in the majority of cases is conservative unless shock is progressive. Certainly when a patient is in progressive shock operation should be performed immediately. In many instances however those patients that are not in progressive shock can be treated satisfactorily with conservative measures. One must be satisfied that the bleeding has been arrested and that there is no additional injury to a hollow viscus. Absolute rest in bed without intravenous administration of fluids which might raise the pressure suddenly and start bleeding anew is the usual program. If there is any indication of further bleeding as evidenced by drop in pressure or

progression of the local signs splenectomy is performed without delay Naturally because of the danger of delayed hemorrhage conservative treatment requires very close observation and hospitalization for a longer period than if splenectomy were performed originally As a rule three weeks in the hospital is advisable Obviously conservative treatment probably will be little used in warfare but in civilian practice there will be many instances in which it can be utilized safely and satisfactorily

In general patients in shock should be prepared for surgical treatment by the administration of blood but beyond this preparation there should be no delay It is generally agreed that suturing rents in the capsule of the spleen will not prevent subsequent subcapsular hemorrhage Exploration also is the only sure method of determining the full extent of the visceral damage and if there is any question of associated injury to a hollow viscus laparotomy should be undertaken

Of the twelve patients seen here eleven were operated on as soon as the diagnosis could be established and as soon as the shock had been controlled In nine cases splenectomy alone was done In one case in addition associated ruptures of the duodenum and liver were sutured One patient had a severely ruptured left kidney which was removed transperitoneally along with the spleen In one case in the series operation was not performed The clinical features of this case were so typical there is little doubt as to the diagnosis A brief report of the case is included since the course illustrates several of the points listed previously The morbidity and the time spent in the hospital were comparable to those of patients who had had splenectomy and some uncertainty existed throughout the patient's stay and afterwards as to the possibility of delayed hemorrhage

The patient a girl of sixteen years was fallen on by two people during a scuffle She was not hurt very badly but came in for treatment twenty four hours after her injury because of persisting pain and tenderness in the left upper quadrant On examination a tender mass was found in the left upper quadrant An excretory urogram showed that the left kidney was displaced downward by the mass The urine was normal Erythrocytes numbered 3 780 000 and leukocytes 13 700 per cubic millimeter of blood The concentration of hemoglobin was 12 gm per 100 cc of blood The general condition of the patient was very good and conservative management was decided on Fever of a spiking type developed and persisted for twelve days The mass gradually decreased in size and became less tender Frequent count of erythrocytes were made and the lowest value obtained was 3 300 000 per cubic millimeter of blood which was taken as evidence that bleeding was continuing The patient was dismissed from the hospital on the twentieth day after the accident with a small mass still palpable

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to the extent of the injuries. The other patient was a girl of eight years. Considerable vomiting developed during the closure of the abdomen following splenectomy. There was some aspiration of vomitus and the child died of pneumonia two days after operation. In such cases it is well to empty the stomach prior to the operation.

Liver—The liver is involved in nonpenetrating injuries more commonly than any other abdominal organ with the exception of the kidneys. Edler¹⁵ reported that the liver was involved in 50 per cent of 365 cases of injuries to solid organs. There were twenty cases of rupture of the liver in the series of ninety-five cases reported by Lewis and Trimble and ten cases in Duncan and Forbes.¹⁴ Series of forty-eight cases. This relative vulnerability of the liver has been attributed by Vance to its large size, its more or less fixed position and the fragility of the organ. On the other hand, the liver receives some measure of protection from the ribs and mobility may give slight aid in escaping injury since it is not entirely fixed.

Essentially the same types of trauma that lead to rupture of the spleen cause rupture of the liver. Crushing injuries seem to be the commonest type. When the liver is normal, fairly severe trauma is usually necessary to rupture it but so-called spontaneous ruptures have been reported, particularly of the enlarged liver. Wakeley⁴¹ pointed out that injuries of the liver were relatively uncommon prior to the widespread use of automobiles. Vance concluded from a necropsy study of twenty-one cases that the most common injury was a laceration of the convex surface in the sagittal plane produced by force applied from the side. Stellate lacerations of the convex surface are fairly common and probably can be explained by direct trauma. The common and usually fatal injury of sagittal laceration virtually fracturing the left from the right lobe is thought to follow crushing of the liver against the vertebral column. The extent of the lesion varies from small lacerations to those that fragment the organ. The laceration may be subcapsular or it may involve both capsule and parenchyma. Vance⁴⁰ and others³³ have described extensive central hemorrhages which are thought to follow trauma that produces torsion of the liver, the effect being similar to that of wringing out of a wet rag. Most of the reported hemorrhages of this type have been found in the right lobe. According to Christopher many subcapsular injuries give only slight symptoms and probably escape diagnosis. When both the parenchyma and the capsule are involved, the usual signs associated with rupture of the liver are found.

The diagnosis of rupture of the liver is at best provisional. Lewis and Trimble pointed out, however, that the diagnosis of intra-abdominal hemorrhage usually can be made and a probable diagnosis of rupture of the liver arrived at from the location of the trauma and from

the rapidity and extent of the bleeding McKnight⁷ found that the direction of extension of the pain was dependent on the site of the hepatic rupture. With ruptures of the convex surface the extension was toward the right scapular region but with ruptures of the concave surface the extension was toward the anterior part of the waist line. Tenderness and spasm are present in most cases if the patient is conscious. Such findings by no means indicate a ruptured liver but rather call the attention of the examiner to the possibility of such an injury. Finsterer¹⁰ observed that bradycardia often was associated with ruptures of the liver and he regarded this sign as of some importance in diagnosis. Orth³ was able to produce bradycardia experimentally on dogs after hepatic injury when there was extensive soiling of the peritoneal cavity with blood and bile. Clinically the sign is rarely observed in cases of ruptured liver and most authors believe that it has little diagnostic importance.

Thirteen patients in the present series had rupture of the liver. Operation was done on ten and the diagnosis was thus proved while in three cases the clinical findings were such that the diagnosis seemed probable. In the cases in which rupture of the liver was proved at operation nine patients were male and one was female and the patients were predominantly children and young adults. Six patients were younger than twenty years and two were younger than ten years. An exact analysis of the trauma causing the accident was not possible in seven cases since the ruptures occurred in automobile accidents. Two patients were injured by being run over, two by blows in the right upper quadrant and two by the kicks of horses. Associated injuries were present in four of the ten cases in which operation was performed.

The frequency of associated injuries led to confusion in the interpretation of the symptoms presented by the patients. In none of the cases in which patients came to operation did the signs point unmistakably to rupture of the liver. Rigidity and tenderness of the upper part of the abdomen were generalized in seven cases and in two others the signs were so definitely localized in the left upper quadrant that the preoperative diagnosis was rupture of the spleen. One patient who complained of colicky abdominal pains had a distended tympanitic abdomen and preoperative diagnosis of intestinal obstruction was made.

Clinical laboratory examinations gave little diagnostic aid. Leukocytosis was present in all cases in which leukocyte counts were made and the average for the series was 21,000 leukocytes per cubic millimeter of blood. The average hemoglobin reading was 11.4 gm per 100 cc of blood.

The usual treatment of ruptures of the liver is light packing of the laceration with gauze. Seven of the ten patients in the present series

on whom operation was performed were so treated. In one case the laceration was sutured and in two the liver was not disturbed because all bleeding had stopped at the time of operation. Hinton¹ stated that most ruptures of the liver will stop bleeding spontaneously and that more harm than good is accomplished by operation. Lamb² however wrote that spontaneous hemostasis is rare in the liver since the blood vessels are thin walled and without valves and do not contract or retract on sectioning and since blood mixed with bile coagulates slowly. In view of the frequency of associated injuries and the difficulty of arriving at the exact diagnosis preoperatively we believe that exploration usually is justified. All detached pieces of hepatic substance should be removed from the peritoneal cavity since death may result from autolytic peritonitis if a sufficient amount of liver is left separated from its blood supply. Boyce and McFetridge⁴ stated that extensively traumatized regions of the liver probably should be resected because of the same danger.

There are unquestionably instances such as the aforementioned two cases at the Clinic in which the bleeding will cease spontaneously, suture or packing is unnecessary, and conservative treatment can be utilized safely. If the patient is in good condition, if the signs of shock are not progressive and if the symptoms point to a cessation of bleeding it has been our practice recently to observe the patient closely and not resort to laparotomy. Thus far this treatment has been very satisfactory in selected cases but one must be certain that there is no associated rent of a hollow viscus. As with the conservative treatment of the ruptured spleen, conservative treatment of the ruptured liver can be carried out readily in civilian practice but probably will have little place in warfare.

Three patients who had probable ruptures of the liver were not operated on. Two were seen immediately after injury and both had pain, tenderness and rigidity well confined to the right upper quadrant of the abdomen. Both had a leukocyte count of more than 18,000 in each cubic millimeter of blood. Both improved rapidly and operation was deferred. Both patients made uneventful recoveries. The third patient was of more interest from the standpoint of the possible complications of hepatic injury.

This patient was a physician aged thirty-six years who had fallen against a water tap, injuring the right upper quadrant of the abdomen four months before coming to the Clinic. Moderate pain and tenderness had developed in the region and a rupture of the liver was thought the most probable diagnosis both by the patient and by his physician. The patient had improved on expectant treatment to the extent that operation had not been done. About one week after the injury mild jaundice and bilirubin had developed. These had persisted. The jaundice was slight and the patient believed that it was decreasing gradually. Mild gaseous indigestion with occasional vomiting also had developed since the accident. Phys-

ical examination at the Clinic failed to disclose significant abnormalities apart from slight tenderness in the right upper quadrant. Since improvement had been steady although slow operation was not advised.

McKnight and others have pointed out that jaundice may not appear after hepatic injury but that if it does occur it is not an early sign.

Five of the ten patients treated by operation died. Four of these had associated injuries. One patient had ruptures of the spleen and duodenum, one had a rupture of the right kidney and multiple fractures of the ribs, one had an extensive retroperitoneal hemorrhage and one had a rupture of the liver which had involved the hepatic ducts. There was much blood and bile in the peritoneal cavity of this patient. At no time was the pulse slow; on the contrary it was fast and thready until the patient's death. The cause of death in all cases was shock and hemorrhage.

This mortality rate after operation for rupture of the liver is similar to that of other reports. Branch⁵ agreed with Deaver and Ashhurst¹³ that the mortality rate after operation was about 60 per cent. Lamb reported a mortality rate of 44 per cent and Lewis and Trimble one of 40 per cent for those patients who had undergone operation.

Hollow Viscera—The hollow abdominal viscera are involved less often than are the solid viscera in nonpenetrating abdominal injuries. Rupture of these organs, however, is of great importance in that such ruptures must be repaired early or peritonitis with probable death will result. Wangenstein pointed out that ultimately all diagnostic procedures when one is dealing with traumatic abdominal injuries are directed toward determining whether there is a rupture of a hollow viscus. When such a rupture is probable there is complete agreement that the surgical repair of the rupture is imperative. The only exception to this would be for those patients who are seen so late that peritonitis has become established and for those patients who are in such grave condition that operation cannot be undertaken. Hinton has stated that often the mortality rate is less when no patients with nonpenetrating abdominal injuries undergo operation than when all such patients undergo operation. The explanation for this lies in the fact that most patients have injuries only to solid viscera and such patients may and frequently do recover without operation.

The diagnosis of injury of a hollow viscus is notoriously difficult and time taken for observation may decrease the patient's chances of recovery. With rupture of the stomach and colon, both relatively rare, gas may be seen under the diaphragm by roentgenographic examination when the patient sits upright but with ruptures of the small intestine which normally does not contain any gas, a plain roentgenogram of the abdomen made soon after the injury will be valueless. The peritoneal reaction produced by contents of the lower bowel may

be slight Nausea and vomiting have little significance and even the vomiting of blood cannot be taken as evidence of rupture of the bowel or stomach since the blood may have originated in lacerations of the mouth or from the nose There is no characteristic change in the blood whether in the leukocytes in the hemoglobin or in the erythrocytes *if shock and hemorrhage are not present* Diagnosis as with other intra abdominal lesions depends on a careful history and physical examination and often cannot be made with certainty until the abdomen has been opened

Twenty one injuries of a hollow viscus have been encountered at the Clinic Their importance is such that they will be reviewed rather fully

Stomach—Subcutaneous rupture of the stomach is an uncommon lesion Glassman¹⁷ found only fifty two cases in the world literature to 1929 and he added two other cases Since that time only occasional reports of single cases have appeared The stomach probably owes its relative immunity to injury to the protection offered by the ribs and to the fact that it usually is not distended Severe trauma evidently is necessary to rupture the normal stomach It follows that associated injuries will be common and hence that the mortality rate will be high There were complicating visceral injuries in 55 per cent of the cases in Glassman's series and the mortality rate was 71.8 per cent

The diagnosis of rupture of the stomach usually is evident from the history the location of the trauma and the marked peritoneal reaction to the escaped gastric contents Only one patient in the present series had subcutaneous rupture of the stomach A resume of his case follows

A farmer aged thirty-eight years was caught and crushed between a tractor and a large cultivating machine Severe pain developed immediately in the upper part of the abdomen and soon this was followed by nausea and the vomiting of dark blood The nausea vomiting and intense pain continued without change and the patient arrived for treatment two hours after the injury He was in excellent shock on arrival his pulse was barely perceptible and his blood pressure could not be taken with certainty The abdomen did not show any external evidence of injury There were generalized abdominal tenderness and marked rigidity slightly more extreme on the left than on the right The leukocytes numbered 24,600 per cubic millimeter of blood and the erythrocytes 4,620,000 The urine was normal

An emergency operation was done as soon as possible Bloody gastric contents were found as soon as the peritoneum was opened and there was a 2½ inch (6 cm.) opening in the anterior wall of the stomach near the greater curvature The laceration was closed with continuous chromic catgut and the peritoneal cavity was drained The patient was given support of acacia and blood transfusions but failed to recover He died thirty hours after the operation There were no associated injuries and death was attributed to shock and hemorrhage with beginning peritonitis

Intestines—Ruptures of the bowel are fairly frequent Cooke⁹ estimated that they were to be found in more than 5 per cent of necropsy cases in which injury had resulted from automobile accidents. A direct blow is the most common form of trauma causing the rupture and many cases have been reported of the bowel being crushed while contained in a hernial sac. According to Berry³ bursting injuries are a pathologic curiosity. The original trauma may cause a frank rupture of the bowel, may only contuse the bowel or may tear loose the mesentery from its insertion into the bowel. In both of the latter conditions so called secondary rupture of the bowel may occur at a later time.

Reports vary as to the most frequent site of rupture of the intestines and Berry collected data on a series of cases from three sources with this in mind. He found that the jejunum or the ileum or both were involved 177 times, the duodenum twenty nine times and the large intestine fifteen times.

As previously pointed out, the symptoms are practically never diagnostic but most authors consider that pain is constant in cases of rupture of the small bowel and Berry wrote that a blow 'followed by severe and continuous localized pain and marked local tenderness indicates almost always rupture of the intestine. Vomiting is not an essential symptom and distention occurs only at a later period. Berry also emphasized the fact proved on animals by Dambrin¹ that after rupture of the intestine there is no immediate large escape of gas or intestinal contents. This delay is due to herniation of the mucous membrane and to contraction of the bowel in the region of the trauma.

Berry proposed a clinical classification of merit in that cases which may be easily missed are emphasized. In the first group are those patients who have a primary rupture involving all of the coats of the bowel with symptoms so definite that operation should be performed immediately. In the second group are the patients who have secondary ruptures which may follow injuries so trivial that the patient may actually walk into the hospital. In the last group are the patients who have associated internal injuries, typically those caused by the patient being run over.

Inlow¹ reported data on two cases of secondary rupture of the intestines and stated that late rupture results from a sloughing and necrosis of the antimesenteric border of the bowel which was previously either contused or deprived of its blood supply by mesenteric separation. The actual perforation occurs about two weeks after the injury and fulminating peritonitis ensues with marked signs of peritoneal irritation thus differing from the signs seen with primary rupture.

The mortality rate of such injuries has always been high, owing chiefly to peritonitis and difficulty in diagnosis. Battle in 1919 re-

ported a 61 per cent mortality rate following operation in 124 cases Berry reported a 79.2 per cent mortality rate after operation in eighty four cases and a 70 per cent mortality rate after operation on thirty different patients. Usually it is assumed that the mortality rate following rupture of the intestine without operation is 100 per cent and in 1858 Poland³³ reported data on a series of fifty three cases in which operation was not performed and in which the patients all died. About half died from collapse within twenty four hours of injury a third died between twenty four and forty eight hours from peritonitis while the remaining patients died between the third and sixteenth day during the reparative attempt.

In the present series twenty patients had subcutaneous injuries to the small intestine. The duodenum was injured in five cases the jejunum in three cases and the ileum in twelve cases. The trauma causing the duodenal injuries differed from that causing injuries to other portions of the small bowel in that four of the five injuries were caused by crushing of the upper part of the abdomen while the injuries of the jejunum and the ileum were the result of localized blows to the abdomen. The most common cause of injury was a kick by a horse and the crushing injuries were for the most part the result of the patient's being run over. The ileum of one patient was ruptured while in a hernial sac.

All of the patients in the series complained of severe and constant abdominal pain which continued even in the presence of shock. Abdominal rigidity and tenderness were associated with all ruptures of the jejunum and duodenum but the findings in half of the cases of rupture of the ileum were so vague that a definite diagnosis could not be made. Vomiting was not constant but seemed to occur more often with injuries to the upper portions of the bowel than with injuries to the lower portions. Four of the five patients who had duodenal rupture had vomited and one had noticed that the vomitus contained blood. Two of the three patients who had rupture of the jejunum had vomited but neither had vomited blood. Only seven of the twelve patients who had rupture of the ileum had any vomiting prior to operation.

The duodenal ruptures were caused by more severe trauma than were the ruptures of other portions of the bowel as judged by the associated injuries. One patient had a rupture of the right kidney one had ruptures of the liver and spleen one had a fracture of the right femur and one had a rupture of the body wall at the costal margin. None of the patients who had rupture of the jejunum had injuries to the other organs and of the twelve patients who had ruptured ileum none had associated intra abdominal lesions and two only had associated injuries of any type in both cases fractures.

(a) Duodenum.—The site of rupture in two cases was in the third

portion of the duodenum and the mechanism was evidently crushing of the duodenum against the vertebral column. In the remaining three cases the first and second portions of the duodenum were involved. In two both the intraperitoneal and the extraperitoneal portions were ruptured while in the other case the rupture was entirely retroperitoneal. Thus in three of the five cases the rupture was entirely retroperitoneal and in two there was an intraperitoneal extension of the rupture.

There was no distinctive age group in the series and both children and adults were included. The time between accident and treatment varied widely from one to twenty-two hours and there seemed to be no correlation between the intensity of the symptoms and the duration of the rupture. All of the patients who had rupture of the duodenum died. The condition of one patient who had been run over by a gangplow eleven hours before admission was too serious to permit exploration and he died twenty-one hours after the accident. In the other four cases exploration was performed. One patient died of shock and hemorrhage twelve hours after the rent in the duodenum had been closed, lacerations of the liver repaired and the spleen removed. Two patients died of bronchopneumonia on the sixth and seventh days respectively after the operation. The final case was of sufficient interest to report in greater detail.

A man of nineteen years was found after an automobile accident crushed between the top of the windshield and the ground, the car having turned over completely. He was unconscious for an undetermined time. On admission four hours after the accident, he had regained consciousness and had vomited several times. His blood pressure was 130 mm. of mercury systolic and 70 diastolic and there was no clinical evidence of shock. However there was hemoconcentration, as shown by an erythrocyte count of 7,400,000 in each cubic millimeter of blood. There was extreme rigidity of the upper part of the abdomen and a bruise was evident in the right upper quadrant. On exploration much food and blood were present in the abdominal cavity and a 7 cm. opening was found in the first portion of the duodenum. This was closed in layers with cutgut reinforced by silk and a drain was left down to the duodenum. There were no other intraperitoneal injuries. The postoperative progress was uneventful until the development of a duodenal fistula and abscess in the region of the incision on the eighth day after operation. Jejunostomy was performed sixteen days after the operation and the condition of the patient was improved by fluids and feeding through the jejunal stoma. Twenty-five days after the accident and nine days after jejunostomy had been performed there was a sudden large hemorrhage from the region of the fistula which caused the death of the patient.

(b) Jejunum.—The three ruptures of the jejunum were situated within 4 feet (1.2 meters) of the ligament of Treitz. The patients all had typical findings and operation was performed without delay. In the two cases in which the patients recovered operation was per-

formed five and seven hours after the accidents. Both patients made uneventful recoveries without the development of peritonitis in spite of the fact that much free fluid was found in the peritoneal cavity.

The third patient was first seen twenty nine hours after being kicked in the abdomen by a horse. He was so little injured that he had walked about for an hour after the injury. The abdominal pain had grown progressively worse and he had vomited twice at eight hours after the accident. On admission he was obviously in shock with pale clammy skin and weak pulse. The abdomen was distended and dull to percussion. On exploration a large quantity of yellowish fluid was found in the peritoneal cavity with recognizable food particles. A rupture of the jejunum 15 cm in length was found 30 cm from the ligament of Treitz. The perforation was closed with three rows of catgut and the peritoneal cavity was drained. The patient failed to recover from the operation and died the same day. At necropsy purulent peritonitis was found but no injuries other than the rupture of the jejunum.

It is entirely probable that earlier intervention would have changed the outcome in this case.

(c) Ileum.—In the twelve cases of subcutaneous injuries to the ileum the ages of the patients ranged from early childhood to old age and there was only one female patient in the group. Seven of the patients had been injured by a horse's kick and one had been injured by a bull and the bowel traumatized while contained in a hernial sac. The symptoms have been outlined previously but the fact that half of the patients had symptoms so indefinite that a diagnosis could not be made is of interest. The time factor was of considerable importance as to prognosis. An average of thirty one hours had elapsed between accident and operation in those cases in which the patient died. On the other hand an average of eleven hours had elapsed between the time of accident and operation in those cases in which the patient recovered. In other words the interval between accident and operation was nearly three times as great for patients who died as for those who recovered. However it is evident that even considerable time does not preclude the possibility of recovery. Shock was present in only four of the cases. In two of these cases the patients died and in two they recovered. The importance of the amount of soiling of the peritoneal cavity also was shown clearly in the series. In five of the seven cases in which the patients died there was definite mention in the operative findings of gross fecal contamination or of the presence of large amounts of ileal contents throughout the abdomen. In the majority of the cases the injury was within 1 meter of the ileocecal valve.

In all cases except one exploration was performed and in this group six of the eleven patients died. The cause of death in every case was peritonitis. In most cases the prognosis could be made with consider-

able certainty at the time of operation from the elapsed time and from the amount of intestinal contents found in the peritoneal cavity. In all cases in which distention was noted it proved at operation to be due to escaped intestinal contents and so constituted a sign of grave significance.

The single patient in the series on whom operation was not performed was seen some years ago. He presented himself for treatment thirty six hours after having been kicked in the abdomen by a horse. His general condition was poor and he had had much vomiting. The abdomen was diffusely tender and distended. Conservative management was decided upon. An abscess developed in the right lower quadrant and was drained but the patient died finally of pneumonia.

Rarely patients recover from a rupture of the small bowel without surgical treatment. One such case was included in the present series.

The patient was a farmer aged sixty two years who had been struck in the right lower quadrant of the abdomen by a pitchfork handle nine months before entry. He had had immediate severe pain in the right lower quadrant but had not been seen by a physician. For five weeks after the accident he had had continuous fever with temperatures of 101° to 103° F and for the next eight months he had had recurring short attacks of fever, vomiting and pain in the right lower quadrant. On examination at the Clinic there were slight tenderness in the right lower quadrant of the abdomen and a definite though ill-defined mass. Exploration was performed. An old rupture of the terminal portion of the ileum closed by adhesions and omentum was found. The patient made a rapid recovery and left the hospital on the tenth day after the operation.

One case in the series probably is an illustration of the fact that a ruptured bowel may not discharge intestinal contents into the peritoneal cavity until some time after the rupture, owing presumably to herniation of the mucous membrane and to the contraction of the circular muscle fibers.

The patient was a boy aged eight years who had been kicked in the abdomen by a horse. He had vomited once soon after the accident but had not complained of any particular pain in the abdomen. He had been seen by a physician who had not found any abnormalities on physical examination. The child had continued up and around after the examination. Twelve hours after the injury with almost explosive suddenness intense severe abdominal pain had developed and shock had followed rapidly. The patient was first seen at the Clinic eight hours after the onset of the pain. Clinical shock was severe at that time and the abdomen was distended, dull to percussion and markedly tender everywhere. Leukocytes numbered 31,800 per cubic millimeter of blood. Exploration was performed as soon as possible and a 2.5 cm rent was found 106 cm from the ileocecal valve with a second small hole 92 cm from the ileocecal valve. The dis-

tention was caused by contents of the small bowel. The lacerations were sutured and drains left in the peritoneal cavity. A fecal fistula developed after operation but this closed spontaneously in about six months. When last heard from the patient had recovered completely.

The treatment of most cases of laceration of the ileum was simple suture of the laceration with catgut. No further surgical treatment was offered in seven of the eleven cases in which exploration was performed. In two of the remaining cases the lacerations were converted into stomas; in one case a loop of bowel denuded of peritoneum was exteriorized and in one case in addition to the closure of the laceration a Witzel type of enterostomy was performed proximal to the repair. In more recent years transduodenal suction has been increasingly used either with the Levine or with the Miller Abbott tube.

Intraperitoneal Hemorrhage.—Three patients in the series had extensive intraperitoneal bleeding without other visceral injury. The trauma was not unusual in that two patients had been crushed and a third had been struck by an automobile, the force in all cases having been applied diffusely to the abdomen. That the patients had been injured severely was evident and they were brought to the hospital as rapidly as possible, all three arriving within an hour of the injury. They were all in shock and in extremely serious condition. In each case enough blood was present in the peritoneal cavity to produce clinically evident distention and a diagnosis of extensive intraperitoneal bleeding was made. In two cases the greater distention and tenderness were found on the right side of the abdomen and in both the bleeding was assumed to be coming from a rupture of the liver. These two patients were prepared for operation with transfusions of solution of acacia and blood and then exploration was performed. In both cases the bleeding was extensive and had originated from the mesocolon. One patient had a laceration of the transverse mesocolon and the other had extensive bleeding from a denuded area of the hepatic flexure. The third patient failed to respond to blood transfusions and his condition was judged too poor to justify operation. Two of the three patients died. In the case in which exploration was not performed the patient was found at necropsy to have a rupture of the middle colic artery.

It is evident from these three cases that under the proper circumstances which probably have to do with the position of the colon, the length of the transverse mesocolon and the application of the force tearing of the mesocolon or avulsion of the colon from the mesocolon occurs. The injury obviously is rapidly fatal unless the bleeding can be controlled. Three such cases in a series of forty-eight cases of non-penetrating abdominal injuries would suggest that intraperitoneal hemorrhage is far more common than many of the published reports would indicate.

Retroperitoneal Hemorrhage—It has become customary to group patients who have retroperitoneal hemorrhage with patients suffering from abdominal injuries because of the similarity of the symptoms and because of the problem of differential diagnosis. Judging from the present series definite retroperitoneal hemorrhage without injury to viscera is an unusual condition. The rupture of any retroperitoneal organ leads to some retroperitoneal bleeding if the capsule of the organ has been torn. It is reasonable to believe that blunt force sufficiently severe to cause rupture of a large vessel would probably also cause rupture of viscera in the region. That this is true is shown by the fact that there was only one patient in the series who had extensive retroperitoneal bleeding apparently without visceral injury and even in his case the diagnosis is doubtful.

This patient had been kicked by a horse in the right upper quadrant of the abdomen and presented on examination marked tenderness and spasm of the right upper quadrant. He was not in shock. Operation was advised because of the possibility of a rupture of the liver. No actual visceral injury was found but there was an extensive hematoma behind the cecum and ascending colon. The blood supply of the ascending colon seemed adequate but because of marked infiltration of blood into the meso appendix, appendectomy was done. The course after operation was stormy because of distention and abdominal pain. Eight days after operation a duodenal fistula developed and drained through the incision. Jejunostomy was done but the patient died seven days later. At necropsy a subdiaphragmatic abscess was found and it was not possible to determine whether the rupture of the duodenum had been missed or had developed secondarily.

TABLE 3—NONPENETRATING INJURIES

Viscera Injured	Cases	Deaths
Liver	13	5
Spleen	12	2
Stomach	1	1
Duodenum	5	3
Jejunum	3	1
Ileum	12	7
Retroperitoneal hemorrhage	1	1
Intrapentoneal hemorrhage	3	2
Total	50	24

Total patients = 48. One patient who had injury to duodenum, liver and spleen is counted three times.

Operation was performed on two other patients (not included in the total statistics) for whom a provisional diagnosis of rupture of the liver had been made. Both had extensive retroperitoneal hematomas which accounted unquestionably for the signs leading to the diagnosis of rupture of the liver. In both cases the right kidney was ruptured. This would seem a fairly common situation and when the signs of injury are confined to the right upper quadrant of the abdomen and flank and when the urine is bloody and the rate of bleeding not excessively rapid it should be possible to manage the patient safely conservatively.

Data on the nonpenetrating abdominal injuries encountered at the Clinic are summarized in Table 3.

SUMMARY

Penetrating and subcutaneous abdominal injuries should be reported separately because of differences in diagnosis, treatment and prognosis.

There is agreement that in cases of penetrating abdominal injuries exploration should be performed as soon as the condition of the patient permits. The only exceptions to this rule are patients suffering from shotgun wounds produced from such a range that the shot has separated and patients who are seen late and are obviously recovering. The straight line rule is of assistance in predicting the viscera probably injured when the bullet has traversed the body completely but it is of less aid when the bullet remains in the body.

Rectal impalements are serious injuries when the peritoneal cavity is entered. Prolonged convalescence with extensive perirectal infection is the rule. Colostomy is usually not necessary in the treatment of the condition.

The mortality rate of subcutaneous injuries of solid viscera is due chiefly to the extent of the visceral damage. Occasionally large blood vessels are opened and the patient dies primarily from loss of blood. When injuries of solid viscera are suspected exploration should be performed as a rule since in no other way can the extent of the damage be determined and active steps be taken to control bleeding. In selected cases however conservative treatment of the ruptured spleen and liver has proved very satisfactory.

In cases of injury to hollow viscera exploration must be performed. Subcutaneous injuries to the stomach and duodenum have a high mortality rate because of associated injuries. Ruptures of the small intestine and colon owe their danger chiefly to peritonitis.

Simple suture of the bowel usually is possible. The use of transduodenal drainage has reduced the proportion of cases in which it is necessary to make proximal stomas. The peritoneal cavity in most of the cases reviewed was drained. Chemotherapy and administration of

blood and plasma will contribute to the lowering of the mortality rate associated with traumatic injuries of the abdomen

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PAIN PRODUCED BY INTRASPINAL TUMOR SIMULATING PAIN CAUSED BY GALLBLADDER DISEASE

Report of a Case

WILLIAM A. BLACK

PAIN may be the only symptom during the early development of tumors of the spinal cord. It may be localized to the spinal column but more often than not it is projected along a nerve root to a localized region of the thorax, abdomen or extremities. Craig⁷ has stated that 80 per cent of tumors of the spinal cord present pain as the initial symptom and that the average duration of the pain is two or more years before signs of compression of the cord appear. The diagnosis before neurologic signs develop is often difficult and mistaken diagnoses have been made with the result that laparotomies have been performed.

Craig⁶ in reviewing 312 cases of proved tumor of the spinal cord found that 10 per cent of the patients had been subjected to operation with the hope of relieving pain. He noted particularly that the gall bladder, the appendix, the fallopian tubes and the uterus were most frequently subjected to exploration. Although occasionally pathologic change was found the pain was not relieved.

The case to be presented is that of a patient with a tumor of the spinal cord whose symptoms masqueraded for three and a half years as those of disease of the gallbladder.

REPORT OF CASE

A white married man, forty years of age, a guard for an aircraft company, came to the Clinic complaining of intermittent pain in the right upper quadrant of the abdomen. For twenty years he had noted ringing in both ears and slowly progressive loss of hearing. For twelve years he had suffered periodic migrainous headaches but not the few years just before he came to the Clinic. Eight years before his admission here he had been treated for nephritis.

Five years before he was admitted at the Clinic he had begun to have pain in the right upper quadrant of the abdomen. This pain extended to the spinal column at the level of the inferior angle of the scapula. Sometimes the pain had seemed to begin in the back and to extend to the upper part of the abdomen following the ribs. The pain had been sharp, lancinating, intermittent and was worse in the morning than later in the day. The maneuver of bending over to tie his shoes always had aggravated the patient's pain. Coughing, sneezing and straining had made the pain worse. The pain usually had been relieved by exercise. Almost constantly, soreness had been present in the right upper quadrant of the abdomen along the lower margin of the thoracic cage. The patient stated that occasionally he had suffered from belching and bloating with gas but he

denied any qualitative dyspepsia even for fatty foods. Eighteen months before he came to the Clinic, or three and a half years after the onset of pain in the region of the gallbladder, the patient had begun to note paresthesia in the lower extremities. The paresthesia began in the great toes and ascended gradually to the iliac crests. Twelve months before the patient's admission here, he had noted some muscular weakness in the lower extremities. This had been manifested by dragging of the right foot, the frequency with which he stumbled, and a limp. The weakness had been slowly progressive without remission, the right leg being worse than the left. Nine months before the man came to the Clinic, he had noted

Preoperative

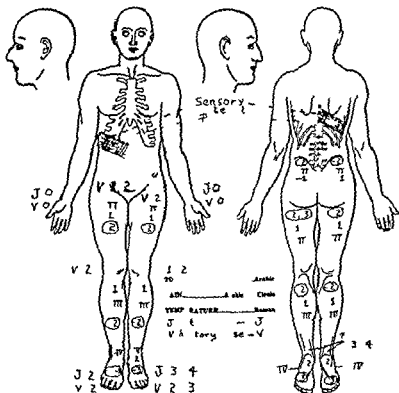


Fig. 334—Situation of pain and degree of sensory impairment based on a scale 1 to 4. 0 is normal. Preoperative findings.

disturbances in function of the bowel and bladder such as fecal urgency and at times incontinence and urinary hesitancy. Six months before his admission the patient's gait had become spastic and unsteady. He had noted difficulty in driving his car and had had to change his foot from accelerator to brake. He stated that he also had noted spontaneous contractions of groups of muscles of his legs. Six weeks before the patient sought care at the Clinic, urinary retention requiring catheterization had developed.

The patient was well nourished, well developed and was not acutely ill. General examination gave essentially negative results.

Examination of the urine revealed albumin grade 3+ but microscopic examination of the sediment did not disclose anything abnormal. Examination of the blood revealed an erythrocyte count of 4 330 000 per cubic millimeter, a leukocyte count of 7 800 per cubic millimeter and a hemoglobin concentration of 14.3 gm per 100 cc. The concentration of urea was 76 mg per 100 cc of blood. The sedimentation rate of erythrocytes was 27 mm per hour. Flocculation tests for syphilis and analysis of gastric content gave negative results. Roentgenographic study of the thoracic and lumbar portions of the spinal column revealed

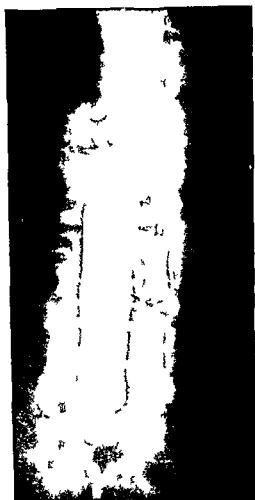


Fig 335—Defect in column of lipiodol due to neurofibroma

only mild hypertrophic changes and spina bifida occulta of the first sacral vertebra. A roentgenogram of the skull was negative.

The sensory examination (Fig 334) revealed impairment of sensation below the eighth or ninth thoracic cord segment. The sensory loss was graded —1 to —3 on the basis that 0 denotes normal and that —4 indicates maximal defect. All sensations were diminished, especially those of pain and temperature. Muscular power in the lower extremities was diminished about 20 per cent and the tonus was increased 25 to 50 per cent. The reflexes in the lower extremities were in



Fig 336—Gross appearance of the neurofibroma

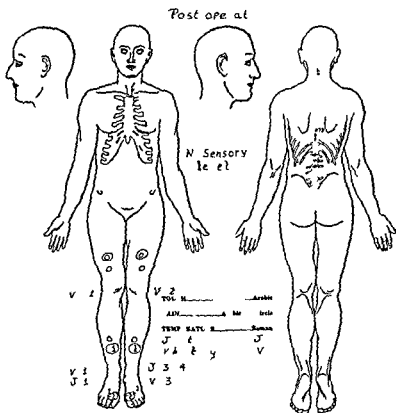


Fig 337—Statistical chart of pain and degree of sensory impairment based on a scale of -1 to -4 0 is normal Findings twenty days after operation

creased and ankle clonus was present bilaterally. The abdominal reflexes were diminished about 75 per cent. The Babinski sign was present bilaterally. The heel knee toe test was carried out poorly. The gait was spastic and unsteady. Romberg's sign was present. The only signs present above the level where the sensory change appeared were bilateral nystagmus on looking laterally, bilateral Hoffman's sign and a nerve type of deafness.

Localized roentgenograms of the region at the eighth thoracic vertebra revealed only slight hypertrophic changes. Spinal puncture revealed the presence of partial subarachnoid block and the cerebrospinal fluid was slightly yellow. The spinal fluid gave a positive test for globulin and the concentration of total protein in the fluid was 320 mg per 100 cc. The cell count of the spinal fluid was normal. Although it was felt that this patient had an intraspinal lesion at the level of the eighth thoracic vertebra, the confusing presence of neurologic signs above the suspected lesion prompted roentgenoscopic examination after introduction of radiopaque oil into the subarachnoid space. This study revealed the presence of an intradural extramedullary tumor on the right side opposite the body of the eighth thoracic vertebra (Fig 335).

Dr Uihlein performed standard bilateral laminectomy with removal of the spines and laminae of the seventh and eighth thoracic vertebrae. The dura was opened directly over a soft yellowish tumor (Fig 336) situated to the right of the spinal cord which extended through the dura into the intervertebral foramen along the course of the right seventh intercostal nerve. The entire tumor was removed and that portion of the dura which immediately surrounded the tumor as it became extradural was sacrificed. The spinal cord was found to be markedly compressed and displaced to the left. At conclusion of the operation the cord was permitted to resume its normal position and the wound was closed.

Grossly the tumor was like a dumbbell in shape, the intradural portion measuring 1 cm in diameter and the extradural portion 1.5 cm in diameter. The tumor was soft yellow and about the consistency of fat. On microscopic examination it was found to be a degenerating neurofibroma.

The patient was immediately free from the pain and soreness in the region of the gallbladder. Neurologic examination made twenty days after operation (Fig 337) disclosed marked return of function of the spinal cord.

COMMENT

Relying greatly on the knowledge and experience of Dr Adson, the following general consideration of tumors of the spinal cord has been assembled. Intraspinous tumors are divided into two types: extramedullary, those arising from the tissues around the spinal cord, and intramedullary, those arising in the cord itself. The case presented represents an example of the extramedullary type of tumor. Frazier has divided the symptoms of extramedullary spinal tumors into three phases: The *first phase* is that of involvement of nerve roots, the *second* that of beginning compression of the spinal cord, and the *third* that of extreme compression of the cord with production of the clinical picture of transverse section of the cord.

The outstanding symptom of involvement of nerve roots is pain and

although pain is not pathognomonic the characteristics of root pain may be typical. Since pain may precede any other symptoms for months or years as was true in the case reported wherein the patient complained of pain and pain only for three and a half years before any other sign appeared it seems worth while to dwell on some of its characteristics. The pain is usually lancinating may be constant or intermittent and is aggravated by coughing sneezing straining lifting or any maneuver that would increase intracranial pressure. Extension of the pain follows the distribution of the nerve root involved. The pain is usually relieved by exercise or by assuming the erect from the reclining position. The mechanism apparently is the ball valve action of the tumor since the tumor is forced downward by the increased pressure of cerebrospinal fluid and this causes traction directly or indirectly on the nerve root.

The symptoms of the second phase are those of beginning compression of the spinal cord. Now neurologic signs become evident. The situation of the tumor in relation to the spinal cord determines the character of the symptoms. If the tumor is anterolateral to the cord the course of the symptoms is toward the Brown Sequard syndrome namely homolateral muscular paralysis and impairment of tactile and deep sensibilities below the level of the lesion and loss or diminution of pain and temperature sensation on the contralateral side. If the tumor is situated posterior to the cord the posterior columns are first to be compressed resulting in impairment of deep sensibilities and appearance of ataxia. Sensory disturbance begins below and gradually progresses upward to a transverse level corresponding to the segment of the cord that is compressed.

With severe compression of the cord in the third phase the following are seen: paralysis below the level of compression loss of all sensation trophic disturbances and loss of control of both vesical and rectal sphincters.

Intramedullary tumors frequently do not produce pain and neurologic signs are the first indications of their presence.

The diagnosis of tumor of the spinal cord during the first phase may be difficult. The projection of the pain to a localized area of the thorax of the abdomen or of an extremity may make differential diagnosis difficult. As in the case reported the patient's complaint of pain and soreness in the right upper quadrant of the abdomen suggested disease of the gallbladder. However he gave no history of nausea or vomiting epigastric distress or fullness after eating especially eating of fatty foods or jaundice. His pain extended along the distribution of a nerve was aggravated by coughing sneezing and straining and was relieved by exercise. When this patient came to the Clinic the diagnosis was not so difficult as it would have been four years before since the associated positive neurologic signs pointed to an intraspinal lesion as the

cause of the pain in the right upper quadrant rather than disease of the gallbladder

Procedure of Examination—A comprehensive and detailed history is a necessary part in the diagnosis of intraspinal lesions since the only symptom pain is a subjective complaint and must be evaluated from what the patient says. Woltman has emphasized seven points to be determined regarding each complaint of pain: (1) situation, depth and projection taken together; (2) frequency; (3) duration; (4) character; (5) intensity; (6) progress; and (7) associated symptoms. Following recording of the history, general as well as neurologic examination is necessary. Special examinations should include spinal puncture, Queckenstedt studies and roentgenographic study of the spinal column with or without the use of radiopaque oil.

Neurologic Examination—The information obtained by a detailed testing of reflexes, muscular strength and tonus, sensory acuity, gait, co-ordination and balance helps to differentiate degenerative lesions from compression of the cord.

Spinal Puncture—Examination of the cerebrospinal fluid obtained by lumbar puncture is one of the most valuable diagnostic procedures. It reveals information concerning the hydrodynamics³ of the fluid and allows collection of a specimen for chemical¹ and cytologic study. As soon as the spinal puncture needle enters the subarachnoid space and before any fluid has been removed, the intraspinal pressure is estimated by means of an Ayer's water manometer which normally registers a pressure of 12 to 15 cm. The next step with the manometer still in place is to make the Queckenstedt test. This consists in reading the rise in pressure when both jugular veins are compressed and the rapidity of fall in pressure when the compression of the veins is released. Sudden rise on compression and rapid fall on release denote a free unobstructed flow of cerebrospinal fluid in the subarachnoid space. Either a slow rise and fall in pressure or no rise on compression of the jugular veins denotes partial or complete intraspinal block. Normally, the fluid is clear and remains fluid on standing. If there is stagnation of the fluid due to intraspinal block, the fluid may be xanthochromic⁸ (Trousseau's syndrome).¹⁰ The cell count usually is normal in the presence of tumor of the spinal cord and this helps to distinguish between intraspinal block due to neoplasm and that due to inflammation. A careful neurologic examination should be done after removal of cerebrospinal fluid since levels of sensory change, reflex changes and muscular weakness may become much more apparent than before.

Roentgenographic Examination—Anteroposterior and lateral roentgenograms of the vertebral column should be made and localized oblique and stereoscopic views should be made in the region where tumor is suspected on clinical grounds. Roentgenographic evidence⁴ of tumor consists in the demonstration of erosion of parts of the ver-

tebrae due to pressure and invasion of the bone by tumor. In the case reported no evidence of tumor was discernible in roentgenograms.

Further information in the diagnosis and particularly the exact localization of intraspinal tumors may be obtained by roentgenoscopic^a and roentgenographic studies after introduction of radiopaque oil into the subarachnoid space. Usually 5 cc. of iodized oil is injected into the lumbar space and on a tilting type of fluoroscopic table the column of oil is studied as it traverses the subarachnoid space. With the roentgenoscope it is possible to note diversions of the column of oil

TABLE 1—SUMMARY OF STUDY OF 557 TUMORS OF THE SPINAL CORD

	Kind of Tumor	Tumors	Per cent
Pathologic Classification	Neurofibromas	163	29
	Meningiomas	140	5
	Intramedullary tumors	64	11.5
	Sarcomas	55	10
	Extramedullary hemangiomas and endotheliomas	47	8.5
	Extramedullary ependymoma	32	6
	Chordomas	23	4
	Miscellaneous intramedullary tumors	33	6
Clinical Distribution	Region of Spinal Cord		
	Cervical	100	18
	Thoracic	304	54
	Lumbar	117	21
	Sacral	35	7
	Multiple levels	1	

around the tumor. It is usually wise to confirm the level of such obstruction with roentgenograms. Intramedullary tumors can be identified by division of the oil into two currents, one on each side of the cord. It has been found by experience that the iodized oil may cause irritation^b of the meninges and may produce radiculitis. Therefore it should be used only when necessary and if possible the oil should be removed at the time of operation. In the case presented a study with iodized oil was advisable to establish definitely the clinical diagnosis of neoplasm since the presence of neurologic signs above the

sensory level could not be explained by the diagnosis of tumor at the seventh thoracic segment of the spinal cord and the diagnosis of multiple sclerosis had been made elsewhere to explain the entire clinical picture

Rasmussen and others classified all verified neoplasms of the spinal cord removed at operation at the Mayo Clinic until 1939. A total of 557 tumors was studied and these were classified pathologically and grouped according to situation (Tables 1 and 2)

It is obvious that the case reported represents the group of the most commonly occurring intraspinal tumors and that the tumor concerned was situated in the region where intraspinal tumors most commonly occur. It is apparent that a large percentage of primary intraspinal tumors are benign and are operable and that their removal effects cure.

Neurofibromas may arise from any part of the nerve so that the tumor may be completely within the dura, may be partly intradural

TABLE 2—SITUATION AND DISTRIBUTION OF 163 NEUROFIBROMAS

Situation	Tumors	Per cent
Cervical	35	22
Thoracic	70	43
Lumbar	55	33.5
Sacral	2	1
Multiple levels	1	0.5

and partly extradural as was true in the case reported or may be completely extradural. These tumors which are partly intradural and partly extradural are termed dumbbell as their appearance suggests. The extradural portion may be so large that it must be removed through a separate incision. The extradural portion of such tumors in the cervical region are best attacked through a separate extraspinal lateral incision; those in the thoracic region may require in addition thoracotomy. In the case reported the extradural portion was small and was accessible through the laminectomy wound. Most neurofibromas tend to degenerate and become cystic when approached at operation; they may rupture and the cyst wall may collapse. This makes identification of the tumors rather difficult. Following removal of extramedullary tumors, marked indentation of the spinal cord due to compression by the tumor is usually noted. Care should be exercised to avoid injury to the cord or its blood supply. Experience has revealed

that function will be recovered if the blood supply is maintained even though a marked indentation is present

RESUME

Localized pain not readily explained on a basis of visceral disease may be due to an intraspinal tumor. In making the differential diagnosis the possibility of such a lesion must be eliminated.

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SUBMUCOSAL NODULES OF THE RECTUM

RAYMOND J JACKMAN AND LOUIS A BUIE

THIS report deals with small submucosal rectal nodules palpable on routine digital examination the mucosa overlying which appeared normal on proctoscopic examination We have excluded those relatively rare tumors which arise ventral to the sacrum presumably from remnants of the postanal gut and known as Middelдорpf tumors or more specifically as teratomas Also we have excluded those presacral tumors which arise from remnants of the notochord commonly spoken of as chordomas tumors of the cauda equina anterior spina bifida with meningocele expanding tumors of the sacrum and inflammatory processes such as internal abscess and fistula Extrarectal masses resulting from carcinomatous or inflammatory processes which occur in the rectovesical or recto uterine spaces or which arise from the male or female genito urinary apparatus have been excluded from our investigation

Specifically this study deals with small (a few millimeters to 3 or 4 cm in diameter) isolated submucosal nodules which occur in the rectum proximal to the dentate margin and which appear to be covered by normal mucosa On palpation these nodules may be confused with polyps or when situated near the pectinate line they may be mistaken for hypertrophied anal papillae and they may seem to be adherent to the mucosa or movable beneath it The differential diagnosis between the submucosal tumor and a polyp or the submucosal tumor and a hypertrophied anal papilla may be impossible without direct visualization of the process Also as might be expected determination of the nature of the submucosal process itself might be impossible without excision of the nodule and histologic study of the tissue removed These tumors are as a rule asymptomatic and frequently are discovered inadvertently at the time of routine digital examination of the rectum Their importance is principally that they may be malignant

In carrying out this study the records of forty seven consecutive patients from each of whom a submucosal tumor was excised and studied microscopically were used

Many regard these submucosal nodules as being of no significance and therefore do nothing about them since they are usually asymptomatic As will be shown in this report these nodules may be malignant or at least may possess malignant potentialities It is because of these factors and the problem of differential diagnosis that they are so important

that function will be recovered if the blood supply is maintained even though a marked indentation is present

RESUME

Localized pain not readily explained on a basis of visceral disease may be due to an intraspinal tumor. In making the differential diagnosis the possibility of such a lesion must be eliminated.

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this type usually will give evidence of chronic inflammatory reaction with fibrosis and foreign body giant cells will be seen surrounding the lipid substance. Given a patient with a submucosal nodule of the



Fig 358—Lipoid granuloma, showing vacuoles surrounded by inflammatory reaction and fibrosis

rectum who has received treatment for internal hemorrhoids by the injection method, it is a reasonably good assumption that the process is a lipoid granuloma (Fig 358)

MALIGNANT SUBMUCOSAL NODULES

Carcinoids.—Two of the nodules were thought to be carcinoids because of characteristics observed in the course of microscopic examination. Symptoms had not been present and the nodules were found on routine digital examination. The diagnosis was made after excision and microscopic examination.

Although a great deal has been written about carcinoid tumors of the appendix and small intestine, there exists very little information

about the occurrence of these tumors in the large bowel. No doubt their presence in this portion of the intestinal tract is relatively rare. Probably this type of tumor originates in the basigranular cells in the depths of the mucosal glands and forms a small circumscribed nodule in the submucosa which projects into the lumen. We found that the cut surface was yellowish and grossly was not unlike the cut surface of some of the tumors caused by oil.⁵ Histologically the

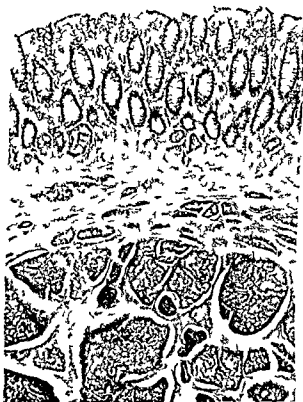


Fig. 339—Adenocarcinoma either carcinoma or cylindroma type. The underlying mucosa is normal.

columnar cells appeared closely packed in nests or masses. Complete identification must rest on demonstration by the silver impregnation method of argentaffin granules in the tumor cells. Usually this tumor is of a very low grade of malignancy but is invasive locally and rare instances of metastasis have been reported. Therefore the tumor should be considered malignant (Fig. 339).

Lymphosarcomas—Two of the isolated submucosal nodules were lymphosarcomas. Here again the process was undoubtedly early and

the lesion was asymptomatic having been found on routine digital examination. One nodule measured about 1.5 by 2 cm and was situated on the left wall at a point about 3 cm above the dentate margin. The mucosa overlying it appeared normal and was movable. Since this patient had been treated by injection for internal hemorrhoids several years previously we were surprised when the pathologists reported lymphosarcoma.

In 1933 N. D. Smith⁴ reported six cases of lymphosarcoma of the rectum and sigmoid. In one case many submucosal rectal nodules were found and, on microscopic examination of one which was excised, changes characteristic of lymphosarcoma were observed. Lymphosarcomas of the rectum may be either a part of a local or of a systemic disease. The growths arise from the lymph follicles or lymph nodes in the submucosa, increase in size, invade the mucosa, become adherent to it and may throw it into adhesive folds and produce ulceration. Clinically, nothing suggested the nature of this lesion and the diagnosis was made by microscopic examination only.

BENIGN SUBMUCOSAL NODULES

Fibromas—Three of the submucosal nodules excised were found to be fibromas. These tumors were made up of fibrous tissue and might have been the result of an inflammatory process of the internal hemorrhoids, since true fibroma is relatively rare. In all instances the process produced no symptoms. In each case the growth seemed adherent to the overlying mucosa and measured 4 to 10 mm in diameter. Also in all three cases only one growth was discovered.

Lipoma—Lipomas of the large intestine are not uncommon. Of the different segments of the intestine which are involved the rectum was second in frequency, only to the cecum and ascending colon according to Pemberton and McCormack. Lipomas may be subserous or submucous and may become sufficiently large to obstruct the lumen of the bowel. Only one of the forty-seven tumors in our series was a lipoma. It was situated on the right anterior rectal wall about 6 cm above the mucocutaneous junction. It measured 1.5 by 1.5 cm in diameter; it was soft and the overlying mucosa was normal. Symptoms were absent.

Leiomyoma—One of the nodules excised was found to be a leiomyoma. Smooth muscle tumors may occur wherever smooth muscle is found in the body and it is logical to expect that this type of lesion would be encountered in this study. In our case the process at first appeared to be a polyp. It had a short pedicle. On close examination the overlying mucosa was found to be normal and when tissue was excised, it gave microscopic evidence that there were interlacing bundles of smooth muscle fibers separated by connective tissue.

Here again the patient did not have any symptoms. Leiomyomas are innocent tumors but most pathologists feel that they may take on malignant characteristics.

INFLAMMATORY SUBMUCOSAL NODULES

Phleboliths—Lime salts may be deposited in an old thrombus and a phlebolith may develop therefrom. Phleboliths are demonstrated commonly in roentgenograms which include the pelvic and prostatic veins. The four patients who harbored this type of submucosal nodule had no symptoms and the diagnosis was made only after excision and gross and microscopic examination.

Fecalith—The submucosal nodule of one female patient was found to be a fecal concretion. The nodule was situated about 8 cm above the dentate margin on the right anterior rectal wall; it measured about 2 by 1.5 cm and the overlying mucosa was normal. The patient had been sent to the Clinic because it was thought that she had a carcinoma of the rectum. The nodule itself did not produce symptoms. It is impossible to explain exactly how this submucosal fecalith occurred but possibly there had been a diverticulum of the rectum in which the concretion formed and had been incarcerated when subsequent inflammatory reaction sealed off the mouth of the diverticulum.

Inflammatory Lymph Node and Enlarged Lymph Follicles—Of four submucosal nodules which were removed and examined histologically, three proved to be enlarged lymph follicle and one was an inflammatory lymph node. The patients had no symptoms and the nature of the nodules was determined only at the time of histologic study of the sections.

Mucous Cyst—With the walls of the rectum containing numerous mucous secreting glands, it is logical to assume that mucous cysts might be a relatively commonly occurring type of submucosal nodule. This type of lesion was typified in only one of the submucosal nodules excised. In our case the lesion was firm, measured about 5 by 5 mm in diameter, appeared bluish and before excision it was thought to be a phlebolith. It contained a clear mucinous fluid. The origin and development of a mucous cyst is similar to that of a sebaceous cyst; it is caused by obstruction of the gland duct.

SUMMARY AND COMMENT

The records of forty-seven consecutive patients from whom submucosal rectal nodules were excised and subjected to microscopic examination have been studied in order to determine the nature of the tumors. All of the lesions were discovered on routine digital examination of the rectum and none produced symptoms. We realize that it is possible for any or all of these lesions to attain sufficient size to pro-

duce symptoms but usually when that occurs they are sufficiently large to be beyond the category of nodules and therefore we did not include them in this study. These nodules are discovered often by the clinician and sometimes they are brushed aside without proper consideration of the grave potentialities. The study which we have made is justified by our discovery that 84 per cent of the nodules were malignant.

CONCLUSIONS

- 1 Most submucosal rectal nodules occur as a result of injection treatment of internal hemorrhoids.
- 2 Most of the remainder of these tumors are either benign or inflammatory but some are malignant.
- 3 Inspection and palpation of the lesion therefore is of little value in making the diagnosis.

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DUPLICATION OF THE RENAL PELVIS AND URETER

LAURENCE F. GREENE

DUPLICATION of the renal pelvis and ureter is a congenital anomaly in which one kidney is supplied with two pelves and two ureters. The condition may be bilateral. The duplication of the ureter may be complete so that two ureters and two ureteral orifices are present, or incomplete in which case one ureter joins the other and there is but one ureteral orifice.

Duplication of the pelvis and ureter is one of the commoner anomalies of the urinary tract and in itself does not carry any clinical significance. Difficulties arise, however, when this condition is associated with pathologic processes in the urinary tract. In such cases the chief difficulty is due to a failure to recognize the condition and make the proper diagnosis.

A diagnosis of duplication of the pelvis and ureter usually can be made with ease by excretory urography. A roentgenogram made preliminary to the injection of the contrast medium frequently will disclose elongation of the renal outline. After intravenous injection of contrast medium a roentgenogram will visualize the duplication of the pelvis and the ureter. The diagnosis may be corroborated or arrived at independently by means of cystoscopy. Cystoscopic examination will disclose two ureteral orifices situated to one side of the midline of the trigone. Catheterization of each ureter and retrograde pyelography will establish the diagnosis.

Unfortunately the methods described in the previous paragraph are not infallible. Visualization of the renal outline and that of the duplicated pelvis and ureter may be obscured by gas in the bowel. A more common difficulty arises when a portion of the kidney drained by one of the pelves is diseased. In that instance the excretion of contrast medium by this segment may not be sufficient to cast a shadow in the roentgenogram and hence only that pelvis which drains the normal renal segment will be visualized. In such cases an intimation of duplication may be gained from a study of the shape, size and position of the visualized pelvis. If only the upper pelvis is visualized it usually appears as a small pelvis from which only two major calices arise (Fig. 340); less frequently only one major calix is present and least commonly three major calices may be noted. If only the lower pelvis is visualized the presence of duplication may be suggested by the position of the upper calix. Instead of extending chiefly superiorly this calix frequently but not always extends chiefly laterally and somewhat superiorly (Fig. 341).

Comparison of the size and position of the visualized renal pelvis with the renal outline may also suggest duplication. It will be noted that the visualized pelvis appears small as compared with the total renal mass. Furthermore, the visualized pelvis will appear to be situated in either the upper or the lower pole of the kidney. Thus if the function of the upper segment of the kidney is poor, only the lower pelvis draining the lower segment will be visualized by excretory urography. Considerable renal parenchyma with no pelvic outlet will be noted



Fig 340—Typical appearance of the upper segment of a duplicated pelvis and ureter

above the visualized lower pelvis (Fig 341). The converse is true if the lower segment of the kidney is functioning poorly (Fig 340).

Cystoscopic examination likewise may fail to disclose the presence of duplication of the pelvis and ureter. There may be duplication of the pelvis and ureter with juncture of the ureters in a common ampulla situated in the intramural portion of the ureter. Cystoscopic examination in such instances will disclose but one ureteral orifice on each side (Case I). Furthermore, the presence of a second ureteral orifice may be overlooked or its appearance obscured as by a ureterocele (Case II). Finally, the second ureteral orifice may not be in the blad-

der at all. It may be present in an ectopic position such as the urethra, vagina, seminal vesicle or rectum and its position may not be determined unless special search is made (Case III).



Fig. 341—Typical appearance of the lower segment of a duplicated pelvis and ureter.

The following three cases illustrate diagnostic errors arising from a failure to detect the presence of duplication of the pelvis and ureter.

REPORT OF CASES

CASE I—A woman forty years old came to the Clinic complaining of recurrent attacks of right abdominal pain of seven months duration. These attacks were associated with chills, fever and pyuria. Six months before admission she had experienced a severe attack and had been placed in a hospital where she remained for several weeks. Urologic investigation had been performed and a shadow suggestive of a ureteral calculus situated in the lower right ureteral area had been noted in the plain roentgenogram. However, roentgenogram made after a lead catheter had been inserted in the right ureter revealed considerable separation between the line of the ureter and the shadow. Therefore the diagnosis of ureteral stone had been altogether omitted. The patient had been given sulfonamide therapy and had improved. A diagnosis of pyelonephritis had been made and a right nephrectomy at a later date had been advised. After

dismissal from the hospital she experienced a further attack and came to the Clinic

The pertinent finding on physical examination was tenderness and muscular spasm of the right midabdominal region. Examination of a catheterized specimen of urine disclosed pus grade 2 (on a basis of 1 to 4 in which 1 designates the least and 4 the greatest amount of pus) and culture revealed *Aerobacter aerogenes*. An excretory urogram was unsatisfactory because visualization of the kidneys was obscured by gas dilatation of the pelvis and calices on the right was noted. A shadow suggestive of ureteral calculus was present in the right lower



Fig 34? (Case 1) —Right retrograde pyelogram in which the lower segment of the duplicated pelvis is visualized. Note distance between original shadow in pelvis and lead catheter

ureteral area. Cystoscopy revealed one ureteral orifice situated at each extremity of the trigone; the right orifice was situated on a papilla and was smaller than the left. A lead catheter was passed up the right ureter easily and no grating was elicited. A right pyelogram disclosed that the original shadow was well removed from the line of the catheter (Fig 34?). From the appearance of the pelvis in the retrograde pyelogram, however, it was apparent that duplication of the pelvis and ureter was present and that only the lower pelvis and ureter had been visualized by pyelography. It was our impression that the ureters joined in an ampulla situated in the intramural portion of the ureter; the original shadow in the lower ureteral area, therefore, was probably a stone located in the ureter

leading to the upper renal pelvis. This impression was corroborated by a subsequent pyelogram which depicted the ureteral duplication (Fig. 343).



Fig. 343 (Case I) — Right retrograde pyelogram in which the upper segment is visualized and the ureteral duplication with juncture at the intramural portion of the ureter is well shown. The stone is in the ureter leading to the upper segment.



Fig. 344 (Case I) — Stone removed from the ureter by manipulation using a transurethral approach.

The stone was extracted from the ureter with the aid of the Council extractor (Fig. 344). Two catheters were passed up the ureter leading to the

upper segment and remained in place four days. At the time of dismissal from the Clinic the patient did not have any urinary symptoms and the results of urinalysis were reported to be negative. One month later she informed us by letter that she felt perfectly well.

The failure to arrive at the correct diagnosis in this case was due to the erroneous impression that the original shadow was excluded from the ureter by virtue of its distance from the lead catheter as shown in the preliminary roentgenogram. An appreciation of the presence of duplication of the pelvis and ureter would have suggested immediately that the shadow was a stone located in the other ureter.

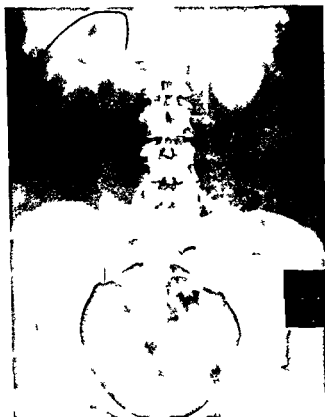


Fig. 345 (Case II)—Excretory urogram revealing a normal pelvis on each side. Note the distance between the superior border of the pelvis and the superior pole of the kidney on the right.

CASE II—A woman aged thirty-four years came to the Clinic complaining of recurrent attacks of pain in the right flank associated with urinary frequency, urgency, pyuria, chills, and fever. The first attack had occurred eight years before admission and thereafter the patient had remained well until two years before admission when the attacks returned with greater severity and frequency. Hysterectomy, salpingectomy, and appendectomy had been performed without benefit. Sulfathiazole had failed to produce permanent relief. One month before

admission to the Clinic the patient had consulted a urologist who had investigated the urinary tract by means of cystoscopy and retrograde pyelography. He had informed the patient that the upper part of the urinary tract was normal. He had noted congestive changes about the vesical neck and the presence of what he interpreted as a cyst near the internal sphincter in the six o'clock position. He had informed the patient that her pain was referred from the urethra and had fulgurated the cyst repeatedly. Because of a recurrence of pain, chills and fever the patient came to the Clinic.

Physical examination revealed slight bilateral tenderness at the costovertebral angle and tenderness of the bladder to bimanual examination. Routine laboratory



Fig. 34 (C c II) —Right ureterogram showing partial visualization of the hydronephrotic dilatation of the upper segment.

examination yielded normal results except for urinary sedimentation of a centrifuged specimen of urine disclosed pus grade 1 and Gram's stain revealed many neutrophils. Bacteria on culture were proved to be *Escherichia coli*.

An excretory urogram (Fig. 345) revealed that the pelvic calices and ureters on the right were of normal configuration but considerable renal parenchyma without emptying system appeared to be present above the dilated pelvis and calices. The pelvic calices and ureter on the left were considered to be normal. From this study a probable diagnosis of dilatation of the pelvic calices and ureter on the right with a poorly functioning upper segment was made.

Cystoscopy was performed and the ureteral orifices appeared normal. A ureterocele was situated inferior and medial to the right ureteral orifice; this undoubtedly was what had been interpreted as a cyst. It was apparent, therefore, that the orifice of the ureter from the upper renal segment was masked by a ureterocele. An attempt was then made to visualize the poorly functioning upper segment on the right by pyelography but this was a failure inasmuch as the catheter coiled in the markedly dilated ureter (Fig. 346). Nevertheless a diagnosis of complete duplication of the pelvis and ureter with poor function of the upper renal segment, hydro-ureter and ureterocele was made.



Fig. 347 (Case II) —Upper segment of right kidney and its hydro-ureter removed at operation.

Surgical intervention was advised and performed. The kidney was mobilized readily; the upper segment was resected from the normal appearing lower segment and the latter was closed. The ureter leading from the upper segment was markedly dilated. Through a small inguinal incision the ureter was dissected free down to the bladder and the upper segment and its ureter were removed through this incision (Fig. 347). The pathologist's report was pyelonephritis, hydronephrosis and hydro-ureter. Convalescence was uneventful and postoperative examination of the lower segment on the right by means of excretory urography and retrograde pyelography revealed normal function and the absence of infection (Fig. 348).

The diagnostic errors in this case were twofold. First there was a failure to appreciate that the pelvis and calices which were visualized on the right actually represented only the lower of two pelves. In fairness it must be stated that the configuration of the visualized pelvis and calices on the right does not suggest duplication but close inspec-



Fig. 348 (Case II)—Right retrograde pyelogram of lower segment after heminephrectomy.

tion of the roentgenograms reveals that considerable renal parenchyma without a pelvic outlet exists above the visualized pelvis. This finding should have suggested duplication of the renal pelvis. The second diagnostic error was the misinterpretation of the ureterocle as a cyst.

CASE III—A girl aged eight years came to the Clinic because of urinary incontinence. Her mother stated that the patient had never gained urinary continence during infancy and that the condition had remained unchanged. She had consulted several physicians and each had made a diagnosis of ureterectasis. The patient's condition had remained constant until the age of eight years. The patient's condition had remained constant until the age of eight years. The patient's condition had remained constant until the age of eight years. The patient's condition had remained constant until the age of eight years.

ability to obtain rubber underclothes she decided to seek further medical advice. She stated that in addition to the constant urinary leakage she voided a normal stream at normal intervals and did not have nocturia or other urinary symptoms.

Physical examination did not reveal any abnormal findings and routine laboratory studies yielded normal results. The results of urinalysis were reported to be normal. An excretory urogram (Fig. 349) revealed dilatation of the pelvis and calices on the right. The pelvis and calices on the left were of normal configura-



Fig. 349 (Case III)—Excretory urogram showing pelvis and calices on the left to be normal but note distance between the tip of upper calix and superior pole of kidney. Note right pyelocaliectasis.

tion but appeared small as compared with the left renal mass. In addition there was considerable renal parenchyma without an emptying system present above the visualized pelvis and calices.

Because of the rather marked pyelocaliectasis on the right, my colleagues and I had the impression prior to cystoscopy that we should find the right ureteral orifice opening in an ectopic position, thereby accounting for the dilatation and urinary incontinence. At cystoscopy we were surprised to find both ureteral orifices in normal position and of normal appearance. A catheter was passed up the right ureter easily and no obstruction was encountered. A right retrograde pyelogram was made and its appearance was similar to that in the excretory urogram.

Having absolved the right kidney we turned our attention to the left kidney. Careful examination of the bladder and urethra failed to disclose an ectopic left ureter. To first inspection the external genitalia appeared to be normal and we were at a loss to explain the urinary incontinence. After diligent search however we noted a suggestion of a papilla located at the juncture of the vestibule and vagina slightly to the left of the external urethral meatus and below it. After considerable manipulation a catheter was passed through an opening in the papilla and up the ectopic left ureter (Fig. 350). This immediately established the



Fig. 50 (Case III) —Left retrograd pyelogram revealing the upper segment of the duplicated pelvis and calyces of the left kidney. The catheter was inserted into the ureteral orifice which opened into the vestibule.

diagnosis of complete duplication of the pelvis calyces and ureter on the left with an ectopic opening of the ureter leading from the upper renal segment. The cause of the right pyelocaliectasis was not determined.

Resection of the upper segment of the left kidney and partial removal of the ectopic ureter were advised and performed. The left kidney was normal in size and was mobilized without difficulty. The ureter leading from the upper segment was dilated by the ureter leading from the lower segment, was normal. The upper segment and a portion of it accompanying ureter were resected (Fig. 351) and the remaining portion of the kidney was closed with interrupted sutures and covered with fat. The pathologist's report was chronic pyelonephritis.

Convalescence was uneventful except for protracted vomiting. At the time of dismissal however the patient felt perfectly well and the results of urinalysis were reported to be normal. The patient was extremely grateful her perineum was dry for the first time in her life. We were pleased and a minor drain on our vital rubber supply was removed.

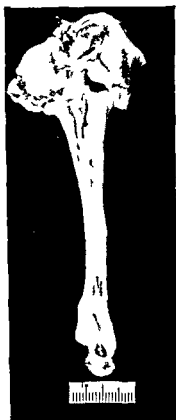


Fig. 351 (Case III) —Upper segment and a portion of ureter removed by heminephrectomy

A careful history would have strongly suggested the proper diagnosis in this case. The patient provided the classic symptoms of constant urinary leakage in spite of normal voidings. The internist who was in charge of the case before urologic consultation was requested stated: "This must be an ectopic ureter." Careful search of the external genitalia with the use of intravenously administered indigo carmine if necessary would have disclosed the ectopic ureteral orifice.

HEADACHE AND PAROXYSMAL HYPERTENSION OBSERVATIONS BEFORE AND AFTER THE SURGICAL REMOVAL OF A PHEOCHROMOCYTOMA

WALTER I. KVALE, GRACE M. ROSE, O. THERON CLAGETT
AND MALCOLM B. DOCKERTY

I. INTRODUCTION AND REPORT OF CASE

WALTER F. KVALE

DURING recent years the syndrome of paroxysmal hypertension due to a pheochromocytoma has become a well recognized clinical entity. The symptoms consist of attacks of severe headache, palpitation, tachycardia, weakness, sweating, and facial pallor which usually last from a few seconds to several hours. The pallor is often characteristically circumoral. However, many other symptoms such as flushing of the face, thoracic pain, dyspnea, choking sensations, dizziness, nervousness, nausea, and vomiting, polyuria, and Raynaud's phenomena can occur. During the attack, both the systolic and diastolic blood pressure increase greatly, and the increase often is alarming. This finding is almost positive evidence of the existence of a pheochromocytoma.

Up to 1939, 103 cases of pheochromocytomas of the adrenal medulla had been reported.¹ About 120 cases have been reported to date. In most of the cases reported in the literature, the tumor was discovered at necropsy. It is probable that the tumor was diagnosed clinically and successfully removed surgically in less than 25 per cent of the cases reported in the literature.

Vaquez and Donzelot were the first to recognize such a tumor clinically and to advise operation. The patient refused operation, but the clinical diagnosis was later confirmed at necropsy. In 1929, Pincoffs correctly diagnosed such a tumor. Removal of the tumor restored the patient to normal health. This was the first time that excision of a pheochromocytoma was performed successfully after a correct clinical diagnosis had been made. By 1938, Mackenzie and McEachern were able to collect fourteen cases from the literature to which they added one of their own, in which the tumor was removed successfully.

Because of the rarity of this type of tumor, I wish to report a case that was observed recently.

REPORT OF CASE

A woman, aged forty-one years, registered at the Clinic May 8, 1943, because of attacks of headache which had been present for four years. Her mother had died of diabetes and had had migraines. Her past history was negative except that she had had influenza in 1918 and pleurisy in 1923. She always had considered

herself in good health although she had suffered from migraine for as long as she could remember. She termed the migrainous headaches ordinary headaches. They had not been particularly severe, had occurred about once or twice a month, and usually had lasted all day. Acetylsalicylic acid generally had produced relief.

The headache that caused her to come to the Clinic was of an entirely different type. One evening while she had been sitting by the kitchen stove, four years previously, she had had a severe pounding generalized headache. She had become very frightened, had broken out in a cold sweat, and had placed her head between her hands. The headache had lasted about ten minutes and had subsided as abruptly as it had started. She had felt perfectly well after the attack had stopped.

Since that time these attacks had continued until she had become pregnant a year and a half before she was referred to the Clinic. The attacks had occurred about once a month and had lasted for five to fifteen minutes. She had noticed that she could precipitate an attack by making pressure on the right side of her abdomen. During her pregnancy the attacks had become more frequent. During the early months they had occurred about once a week, and during the final three months they had occurred as often as two or three times in a single day. She never had vomited during an attack until toward the final months of pregnancy. After the birth of her baby, the attacks had continued to become more frequent; they had occurred five to six times a day, usually in the morning. They had begun to occur in rapid succession and during the two months before she came to the Clinic they had occurred innumerable times during the day.

The attacks were always identical in nature. They were ushered in by a sudden severe generalized headache. Her heart would often beat rapidly, yet at other times her headache was so severe that any abnormality of the heartbeat went unnoticed. She always became frightened, panicky, and had developed the habit of holding her head in her hands until the headache subsided in one to fifteen minutes. She generally broke out in a cold sweat. Her husband had noticed that she frequently would become very pale and that this was particularly noticeable about the lips. After the attack had subsided she usually felt fine, although she sometimes felt a little weak.

Between the attacks she had enjoyed good health. After the birth of her baby, however, in January, 1943, she had become more tired than usual, had become weaker, and had lost about 17 pounds (5.4 kg).

Physical examination revealed a thin, poorly nourished apprehensive woman. Her height was 5 feet 5 inches (165.1 cm) and she weighed 118 pounds (53.5 kg). The systolic blood pressure varied between 158 and 130 mm of mercury and the diastolic varied between 117 and 100 mm. The pulse rate was 134. Ophthalmoscopic examination disclosed narrowing grade 1 and sclerosis grade 1 (on the basis of 1 to 4, in which 1 designates the mildest and 4 the most severe condition) of the retinal arterioles, a moderately large hemorrhage in the optic disk of the left eye, and a smaller hemorrhagic region in the upper nasal margin of the optic disk of the right eye. The tonsils were enlarged and contained pus. The heart was essentially normal except for the presence of a faint systolic bruit at the apex. Examination of the abdomen revealed a mass in the right flank, which was considered to be the right kidney. Just above and medial to this there was an area that was rather tender.

The specific gravity of the urine was 1.024. Urinalysis disclosed albuminuria grade 2. The concentration of hemoglobin was 11.4 gm per 100 cc of blood. The erythrocyte count was 4,490,000 and the leukocyte count was 14,300 per cubic millimeter of blood respectively. A differential blood count did not disclose any diagnostic abnormality. A flocculation test for syphilis was negative. The concentration of urea was 30 mg per 100 cc of blood and the value for the fasting blood sugar which was determined on two occasions, as 150 mg and 143 mg per 100 cc respectively. The basal metabolic rate which also was determined on two occasions was +17 per cent and +7 per cent respectively. The electrocardiogram revealed a cardiac rate of 91, sinus tachycardia, slight QRS complex in derivations I, II and III, slight axis deviation to the left, a deep S wave in derivation II, a deep amplitude of the T wave in derivation III. Roentgenograms of the head and thorax were normal. Stereoscopic roentgenograms of the renal and suprarenal regions revealed a very ill defined area of increased density at the superior pole of the right kidney. The excretory urogram revealed that the renal pelvis was normal on both sides but there was definite ptosis of the right kidney and a soft tissue mass above the right kidney.

The patient's family physician made a tentative diagnosis of chromaffinoma and referred her to the Clinic. He stated that he had seen her in one of the attacks and had found that her blood pressure was 240 mm of mercury systolic and 120 mm diastolic. His assistant also had seen her recently and had found that her blood pressure was 260 mm systolic and 126 mm diastolic. In view of this information the rather typical history, a palpable right kidney with an area of tenderness medial and above this kidney and the roentgenologic finding of a soft tissue shadow above the right kidney, a diagnosis of pheochromocytoma on the right side was made.

II. PHYSIOLOGIC CONSIDERATION

GRACE M. ROTH

Although adrenin has been isolated frequently from these pheochromocytomas that have been removed surgically or discovered at necropsy, and although the clinical symptoms of these tumors can be explained by the absorption of excessive amounts of adrenin because of the lack of a reliable method for determining the amount of adrenin in the circulating blood, an accurate diagnosis of this condition has had to be made by indirect methods. In only one instance in the literature has the presence of a definite pressor substance been determined during an attack. Beer, King and Prinzmetal were able to demonstrate a pressor substance in the blood during a hypertensive crisis induced by exercise. At that time blood plasma was obtained while the systolic blood pressure was more than 300 mm of mercury. A marked pressor effect was produced by the almost immediate perfusion of this plasma through a denervated rabbit's ear. This was in contrast to the effect produced by plasma of a normal subject. Since ergotamine is known to annul the excitatory response of adrenin, shortly thereafter the denervated rabbit's ear was perfused with 1:300,000 solution of ergo-

amine tartrate. Subsequently the patient's plasma was again perfused through the ear and at this time the pressor response had disappeared. It was felt that this reversal effect of ergotamine tartrate on the pressor response of the patient's plasma was most certainly due to adrenin. This was later proven at operation.

Although the severe headache was the chief symptom of the case we are reporting, paroxysmal hypertension was the most conspicuous

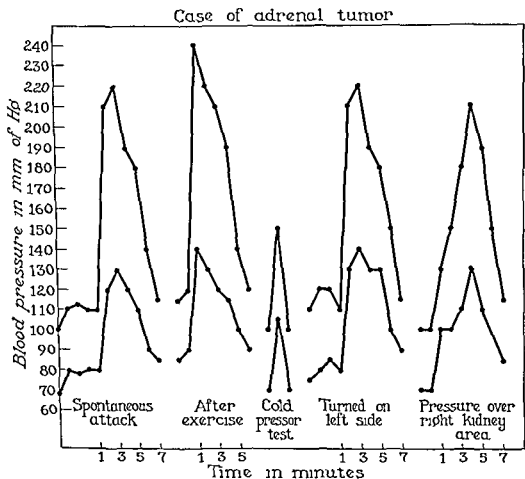


Fig. 352—Changes in blood pressure during a spontaneous attack and changes induced by mild exercise by immersion of patient's hand in cold water by turning the patient on her left side and by making pressure over the right kidney

feature and the question arose as to whether this was due to the sudden massive discharge of adrenin by a tumor into the general circulation. This brings up the question of the secretion of adrenin. Various controversies have occurred as to whether or not adrenin is discharged continuously into the blood stream under normal circumstances. The more recent work of Cannon has given experimental proof that the suprarenal medulla does not secrete unless it is stimulated by nervous

impulses that is by stimulation of the splanchnic nerve puncture of the fourth ventricle or excitation of the sensory nerves. Asphyxia strenuous exercise emotional reactions such as fear or anxiety or the administration of various drugs would liberate adrenin. Best and Taylor also have stated that massage of the suprarenal gland causes passage of adrenin into the blood stream.

Case of adrenal tumor

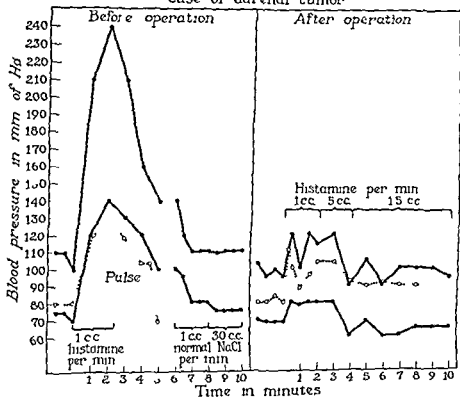


Fig. 353—Changes in blood pressure resulting from the intravenous administration of a 1:250,000 solution of histamine at the rate of 1 cc per minute before removal of tumor and changes resulting from the intravenous administration of physiological solution at the rate of 1 cc per minute after removal of the tumor.

Since a method for determining the amount of adrenin in the blood is still not available physiologic observations were made under basal conditions and during the attacks in the case we are reporting. These studies were limited because although the attacks occurred frequently they were of short duration.

Figure 352 shows some of the changes in blood pressure which occurred during a spontaneous attack after exercise after turning the

patient on her left side and after making pressure over the right kidney. Severe headache, palpitation and pallor of the circumoral region of the face occurred with the increase in the blood pressure. The attack lasted about five minutes. On another occasion after the patient had walked upstairs rapidly an attack occurred which was similar to the spontaneous attacks; in fact blood pressure was even higher. At the height of this attack the chemical composition of the blood was normal except that the concentration of blood sugar was 143 mg per 100 cc. At another time the value for the blood sugar was 150 mg per 100 cc.

The increase in the blood pressure produced by the cold pressor test was slight in comparison with the rise in blood pressure observed during the paroxysmal attack. By turning the patient on her left side an attack could generally be produced. This attack was similar to the other attacks and pressure over the right kidney produced a similar attack.

The patient was found to be hyposensitive to a subcutaneous injection of 1 cc of a 1:100,000 solution of epinephrine. An attack, however, could not be precipitated by the subcutaneous administration of 15 units of insulin which has been used to provoke attacks because of the antagonism which exists between insulin and adrenalin.

An attempt was made to inhibit the rise in blood pressure by the intravenous administration of a 1:250,000 solution of histamine at the rate of 1 cc per minute. The changes produced in the blood pressure are shown in Figure 353. At the end of two minutes the blood pressure had risen to 240 systolic and 140 diastolic and when the administration of histamine was discontinued the blood pressure promptly fell. To rule out psychic stimulation, physiologic salt solution was administered shortly afterwards but no rise in blood pressure occurred. After operation the same test was made without a significant change in blood pressure. Further investigations in regard to these observations will be necessary.

These various observations together with the clinical findings led us to believe that in this case the attacks could be produced by conditions which normally stimulate an increased flow of adrenin and that the paroxysmal character of the hypertension could be explained by a high concentration of adrenin in the tumor.

III SURGICAL CONSIDERATION

O. THERON CLAGETT

Tumors of the suprarenal medulla occur with much less frequency than do tumors which involve the cortex of the suprarenal gland. Relatively only a few cases of medullary tumor have been reported. In 1939 Brunschwig and Humphreys were able to collect 103 cases from

the literature and since then only a few individual cases have been reported. In most of the cases that have been reported the tumors were found at necropsy. I have been able to find reports of only thirty one cases in which surgical removal of these tumors has been attempted.

The first case that was observed at the Clinic was reported by Dr C H Mayo in 1927. His was the first or second case in which operation was performed. The case which we are reporting is the fourth in which operation for this type of tumor has been performed at the Clinic.

In the 103 cases collected by Brunschwig and Humphreys the site of the tumor was as follows: on the right side in forty three cases, on the left side in thirty four cases and outside the suprarenal gland in thirteen cases. The involvement was bilateral in thirteen of the 103 cases. Although this type of tumor has been found in children it is primarily a disease of adults. The distribution of patients according to sex is about equal.

In the case which we are reporting we fortunately had rather definite evidence that the tumor was on the right side. In a number of cases it has been difficult to determine the situation of the tumor. The anatomic inaccessibility of the suprarenal region makes it impossible in most instances to locate the tumors by physical examination. Furthermore the tumor often is too small to permit its localization by palpation.

The best way to locate this type of tumors is by excretory urography and retrograde pyelography. These procedures often disclose some downward displacement of the kidney on the involved side which indicates the presence of a tumor and in some cases they reveal a soft tissue shadow above the kidney. It has been suggested that roentgenographic examination of the renal region after injection of air into the perirenal tissues might aid in locating the tumor. This procedure is not without some danger. It has been attempted at the Clinic on a few occasions but has been abandoned.

If the site of the tumor has been located accurately before operation the best surgical approach is the usual posterolateral kidney incision with removal of the twelfth rib if necessary. In cases in which the site of the tumor cannot be located before operation Brunschwig, Humphreys and Roome and Coller Field and Durant favored a mid line incision in the upper part of the abdominal wall. In such cases Young preferred to place the patient in the prone position and explore the suprarenal regions by means of separate posterior incisions. I have had no experience with these approaches. I believe however that the posterolateral approach offers the best surgical access to the region in most cases. Adequate exposure is extremely important particularly on the right side because here the suprarenal gland lies

directly on the inferior vena cava and its vessels are very short and friable. Furthermore it is important that the tumor be removed with as little manipulation as possible as excessive handling of the tumor may squeeze large quantities of adrenin into the circulatory system and cause an extreme elevation of blood pressure. Patients have died during the operation because of this factor. This type of tumor is very vascular and usually is surrounded by a plexus of large veins which have thin walls. Fortunately for the surgeon this type of tumor almost invariably is well encapsulated.

The choice of anesthesia is very important. When spinal anesthesia is used for the removal of this type of tumor the blood pressure is difficult to control; therefore this type of anesthesia is contraindicated. In the case that we are reporting a general anesthetic was administered through an intratracheal tube. A cannula was inserted into a vein so that it would be available for the intravenous administration of fluids in case this procedure was necessary in the course of the operation. Sodium nitrite was available to combat an excessive rise in the blood pressure and epinephrine was available to combat any decrease in the pressure. With these arrangements we were prepared for almost anything that might happen.

The operation was completely without incident. During the operation the systolic blood pressure never rose above 200 mm. of mercury and never fell below 50 mm. The convalescence was completely uneventful except for an attack of gallbladder colic which occurred on the eighth day after operation. The patient has had one other attack of colic and recent roentgenographic studies reveal the presence of gallstones. We plan to perform a cholecystectomy in the near future. The value for the blood pressure remained normal (90 to 110 mm. systolic) after the operation. When the patient was dismissed from the hospital on the fourteenth day after operation the wound had healed.

According to Best and Taylor the concentration of adrenin in the resting suprarenal gland is about 0.1 per cent of its moist weight and the total amount in the suprarenal glands of man is about 10 mg. The tumor weighed 198 gm. when removed. Doctor Kendall was able to extract 687 mg. of pure crystallized adrenin from the tumor or 3.44 mg. of adrenin per gram of tissue. It has been estimated that the adrenin extracted from this tumor would make 700 ampules of the regular 1:1,000 solution of epinephrine that is produced commercially.

We believe that this is the thirty-second case of tumor of the adrenal medulla in which operation has been performed. Eight deaths have been reported, a mortality rate of 25 per cent. We believe that with proper preoperative and postoperative care, with anesthesia administered as suggested by Doctor Lundy and with minimal handling

of the tumor during surgical removal the risk of operation can be reduced very materially. Although this type of tumor appears to be relatively rare it may be that its rarity may be more apparent than real.

The physician who referred this patient to the Clinic certainly is to be congratulated for having made the original diagnosis of this rare condition.

IV PATHOLOGIC CONSIDERATION

MALCOLM B DOCKERTY

The suprarenal glands consist of yellowish cortical and brownish medullary tissues fused together into homogeneous units. However this unification exists only in the higher forms of life for embryolog

HISTOGENESIS OF ADRENAL MEDULLARY TUMORS

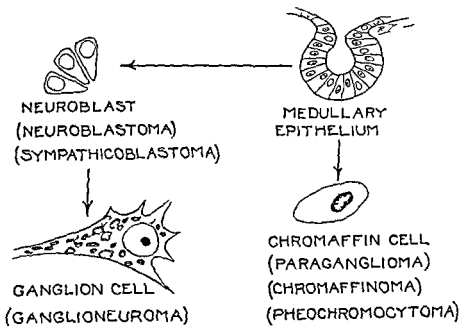


Fig 354—Histogenesis of tumor of the suprarenal medulla

ically in all species possessing suprarenal glands and anatomically in certain of the lower forms cortical and medullary components are entirely disassociated. The cortical elements are derived from the lining of the celomic cavity and are mesodermal. The medullary component springs from the neuro ectoderm. A glance at Figure 354 reveals that this primitive neuro ectoderm (medullary epithelium) gives rise to two main lines of sympathetic nerve cells which may be

identified in the development of the suprarenal medulla. Neuroblasts are the embryonic cells of the first line and give rise to neuroblastomas or sympathocoblastomas, reputedly the second most common abdominal tumor of childhood. Left-sided tumors tend to metastasize to the skull probably by way of the vertebral system of veins. This type is often referred to as the Hutchinson tumor. The liver being in contact with the right suprarenal gland, is the site of early metastasis of a neuroblastoma on the right side, commonly called the Pepper type. Both types are highly malignant, as are also neuroblastomas which occur elsewhere than in the suprarenal medulla.

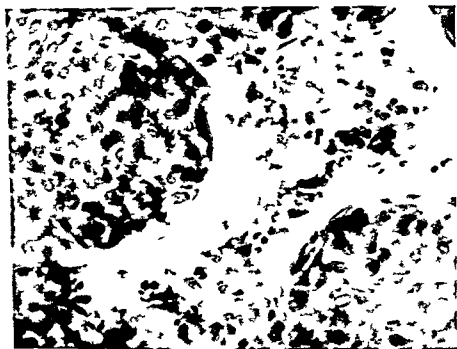


FIG. 333.—Pheochromocytoma showing the dark staining spindle cells lying in close proximity to a thin-walled vascular space. Such a relation might explain the sudden release of adrenal n. n. to the general circulation. Section stained with hematoxylin and eosin ($\times 100$).

Ganglion cells may be regarded as differentiated neuroblasts and are seen in ganglioneuromas. These tumors are rare in the suprarenal glands and are more commonly encountered in connection with the sympathetic ganglia of the cervical, mediastinal and retroperitoneal chains. In adults ganglioneuromas are usually benign, but among children, an admixture of neuroblasts is sometimes found and the resulting tumor being only partially differentiated, is malignant.

Stemming from the second line of descent (Fig. 334) is a cell characterized by the development of cytoplasmic granules possessing an affinity for chromium salts and accordingly called a "chromaffin

cell. Such cells are by no means limited to the suprarenal medulla but occur in the carotid body, organ of Zuckerkandl and elsewhere. Tumors may arise from chromaffin cells in these various sites and the cells of the tumors so formed retain the property of chromaffinity (Figs 355 and 356).

The terms chromaffinoma and pheochromocytoma have by common consent been used to describe suprarenal tumors of this type in



Fig. 356.—Photomicrograph showing particularly finely stippled chromaffin granules in the cytoplasm of the tumor cells. Stained with hematoxylin and eosin ($\times 35$).

asmuch as they almost exclusively produce the clinical phenomena of hyperadrenalism. The term paraganglionoma is reserved for extra-adrenal chromaffinomas such as tumors of the carotid body. Paraganglionomas rarely produce paroxysmal hypertension. As a matter of fact recent studies have shown that even in chromaffinomas of the suprarenal gland the cytoplasmic granules have nothing to do with the production of adrenin by the tumor cells.

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RENAL ECTOPIA

DEWARD O. FERRIS

ANOMALIES of the upper part of the urinary tract are observed more commonly than anomalies of any other system of the body. Although all such anomalies are not pathologic lesions, fully 40 per cent of all pathologic conditions of the kidney and ureter are due to congenital anomalies. These anomalies assume clinical importance in connection with the diagnosis of intra abdominal swellings.

During the early intra uterine period the primitive kidney occupies a position in the region of the future true pelvic cavity. In the course of development it usually ascends to the ultimate lumbar position. As a consequence of incomplete migration the kidney may assume permanently an abnormal position. This condition is known as renal ectopia. The ascent of the kidney may be arrested in the pelvic iliac or lumbar region. The pelvic region is the most frequent site of an ectopic kidney. The ectopic kidney in any site is surrounded by innumerable blood vessels from various sources.

In recent weeks three cases of renal ectopia encountered by three different surgeons at the Clinic have presented problems in diagnosis and treatment.

REPORT OF CASES

CASE I—A married man aged thirty nine years first registered at the Clinic early in 1940. Her chief complaint was pain in the right lower quadrant of the abdomen which had been present for five months. She also stated that she had never been really well since the left ovary had been removed in 1937.

On examination of the abdomen no abnormality was found except a tender cystic mass in the region of the right adnexa of the uterus and a uterus which was as typical normal size. She had not had menorrhagia or metrorrhagia and her symptoms were sufficiently distressing to justify operation at that time.

The patient again presented herself at the Clinic on August 30, 1943, complaining of menorrhagia of three months duration. The findings on physical examination etc. identical with those on the previous visit except that the uterus was considerably larger and extended halfway to the umbilicus. Routine laboratory examination of the urine revealed a specific gravity of 1.00, no albumin, no sugar and microscopic examination of the urine gave negative results. She had 14 gm. of hemoglobin per 100 cc. of blood and 45,000 erythrocytes and 9,400 leukocytes per cubic millimeter of blood. Roentgenograms of the thorax did not reveal any abnormality.

At operation performed on September 1, 1943, through a scoldry low midline incision multiple uterine fibroids, bilateral chronic salpingitis and right cystic oophoritis were found. Total abdominal hysterectomy, bilateral salpingectomy and right oophorectomy were performed. Ovarian exploration of the abdomen

the right kidney was found in its normal position but the left was situated at the brim of the pelvis. Its blood supply was normal and it was normal in all other respects. Consequently it was not disturbed.



Fig. 357 (Case I)—Excretory urogram the outline of the left kidney is visualized overlying the sacrum

The patient made an uneventful convalescence and an excretory urogram was made before she was dismissed from the Clinic (Fig. 357).

CASE II—A married woman, aged twenty five years came to the Clinic in April 1943 complaining that four years previously she had lost 70 pounds (91 kg) and could not regain her normal weight. She also stated that at the same time she had had an attack of pain in the right lower quadrant of the abdomen which lasted seven days. During the first three days of this attack she had suffered from nausea and vomiting. The doctor in her home locality had diagnosed her condition at that time as right ovarian cyst with torsion.

On examination at the Clinic an exophthalmic goiter was found and thyroidectomy was performed. The patient returned later for consideration of the mass in her pelvis. Physical examination revealed a cystic mass in the region of the right uterine adnexa. No other abnormalities were noted. Routine laboratory examination of urine and blood as well as a roentgenogram of the thorax, revealed nothing abnormal. The basal metabolic rate was normal.

The patient was advised to have exploration of the right adnexal mass. She consented and on August 3, 1943, through a primary low midline incision a

retroperitoneal tumor just above the rim of the true pelvis as found which displaced the cecum and terminal portion of the ileum anteriorly. On incising the peritoneum the mass was found to be the right kidney. It was normal in all respects except its position. The only pathological lesions noted within the abdomen and pelvis was a appendicitis grade 3 (on a grading basis of 1 to 4) for which appendectomy was performed. The kidney was not disturbed.



Fig. 358 (Case II) —The right kidney is visualized clearly on the sacrum. The right ureter is also outlined.

The patient's convalescence was uneventful and during this time an excretory rogram was made which revealed no abnormality other than the ectopic right kidney (Fig. 358).

CASE III—An unmarried woman aged twenty-eight years entered the Clinic on August 12, 1943, for general examination. Physical examination revealed a well-developed and well-nourished woman with no abnormalities except a large cystic mass in the region of the right adnexa of the uterus. Routine laboratory examination of the blood and urine as well as a roentgenogram of the thorax revealed nothing abnormal.

Exploration of the pelvic mass was advised. On August 27, 1943, through a primary low midline incision exploration of the entire abdomen was carried out. The only abnormality found was the absence of the right kidney from its usual position and the finding of a cystic mass measuring approximately 18 by 12 by 10 cm. in the right side of the true pelvis. The left kidney was entirely normal. On incising the peritoneum overlying the pelvic mass it was found to be the

right kidney. In addition to its abnormal location it was hydronephrotic grade 3. This ectopic kidney derived its blood supply from the right hypogastric artery through several branches, one of which caused marked angulation of ureter just below the ureteropelvic juncture and presumably was the cause of the hydro-nephrosis. Right nephrectomy was performed. The pathologists reported hydro-nephrosis with destruction of approximately 80 per cent of renal substance.

The patient had an uneventful convalescence.

COMMENT

I have reported these cases to serve as a reminder of the possibility of ectopic kidney in all cases in which a pelvic mass is found. The condition is easily diagnosed by excretory urogram.

In Cases I and II the ectopic kidney did not require treatment but in Case III it did. Treatment should be chosen in accordance not only with the anomaly but also with the nature of the pathologic condition of the kidney. Each case is an individual problem.

All of these three patients were women in the child bearing age and it is conceivable that an ectopic kidney situated in the true pelvis could interfere with parturition. It might be so bound down by blood vessels that it could not rise out of the pelvis with the enlarging uterus and thus might interfere with parturition. In such a situation I believe nephrectomy is indicated.

TREATMENT FOR CONGENITAL ABSENCE OF THE VAGINA

VIRGIL S. COUNSELLER AND FITCHER S. SLUDER, JR.

As has been pointed out by Falls² one of the greatest difficulties in developing an adequate technic for the treatment of congenital absence of the vagina is the lack of suitable clinical material on which to base technical experience. Numerous procedures have been devised for correction of this anomaly. Descriptions of these methods and of various modifications of them are numerous and readily available in the literature. With the exception of one or two series of patients however the number treated by any one surgeon has been limited. In the literature are many reports of single cases in which success was partial or good with a given technic. The unreported single cases of failure or if the bowel has been employed of deaths must be as numerous as if not more numerous than those mentioned in the previous sentence.

The McIndoe Counseller method has been used by the senior author in thirty five cases in the last seven years. The surgical technic gradually has been adapted and altered as also has the care of these patients so that now a fairly standard technic is used with definitely predictable results. Many difficulties have been overcome and much has been learned through the opportunity to arrive at a standard procedure if in no other way than by trial and error.

In a more extensive article now in preparation this surgical technic will be described in detail the changes that have been made and the reasons for the changes will be enumerated and shortcomings and complications will be discussed. By evaluating the cases in which operation has been performed by one surgeon with one technic as part of a total of sixty six cases in which five surgeons at one institution have employed various surgical procedures it is hoped that some definite contribution may be made to understanding of and treatment in these cases.

HISTORY AND PHYSICAL FINDINGS IN THIRTY FIVE CASES

In feminine physical development, mental capabilities, race and economic status the present thirty five patients were a cross section of young womanhood. Their outlook ran the gamut of the types of psychological adjustment from suicidal tendencies through assumed indifference to a childlike faith that their condition could be relieved by surgical means much as a birthmark might be removed or a deviated septum might be straightened. Beneath this outward adjustment how

ever lay a profound feeling of inferiority which bade fair ultimately to wreck their lives emotionally.

With the exception of five patients all were less than twenty six years of age and twenty of them were between the ages of eighteen and twenty two years. No regular lower abdominal discomfort, mammary tenderness or general malaise was noted by nineteen (54.3 per cent) while the remainder (45.7 per cent) had a definite molimen. In three of the latter group the symptoms were sufficient to require removal of the uterus with its functioning endometrium and a fourth patient is to return for a similar procedure. In this same group the time of the first appearance of molimen varied from the normal age of thirteen years to twenty three years. In at least six cases molimen did not develop until the patients had been given estrogens by their physicians who had mistakenly assumed that the condition present was simple amenorrhea.

Either unilateral or bilateral hernias occurred in six (17 per cent) of the cases. Three of these hernias were repaired at the time of operation to construct a vagina and three had been repaired previously. In three of the cases an ovary was found presenting at the inguinal ring.

Twelve (34 per cent) of the patients previously had undergone operative procedures on the vagina. If this consisted of a mere incision for imperforate hymen the rectovesical space was disturbed very little. If a serious attempt previously had been made to open this space the difficulty of construction of a vagina was increased tremendously.

The infantile uterus in these cases usually consists of a band like structure running across the pelvis with atrophic tubes and normal ovaries attached. The concentration of estrin in the urine varies within normal limits and a corpus luteum frequently has been observed in the ovaries.

Fifteen of the patients were investigated urologically. The kidneys of six were normal. Of the remaining nine patients the left kidneys of six were found congenitally absent, two had ectopic pelvic left kidneys and one had a duplication of the left ureter. Thus even though less than half of the patients underwent urologic investigation, nine (75.7 per cent) had some major anomaly of the urinary tract.

SURGICAL TECHNIC

The opening of the rectovesical space if it has not been disturbed previously is not technically difficult. Proper orientation is essential. This is facilitated by placing a de Pezzer catheter in the bladder, carefully palpating the anterior rectal wall and palpating the vaginal dimple which usually will reveal the upper limits of the perineal body and indicate the plane of cleavage to be followed.

Anteroposterior traction is made on the vaginal dimple and a trans

verse incision is made through the mucous membrane midway between anus and urethral meatus and just above the upper limits of the perineal body. The small amount of tissue separating the rectum and bladder is arranged in transverse sheets and forms a well defined plane of cleavage. By blunt separation the bladder is pushed upward and the rectum downward. The peritoneum usually is encountered before the desired depth is reached but it can easily be rolled upward and backward from the anterior rectal wall.

The percentage of loss of the skin graft soon to be described is directly proportional to the amount of bleeding encountered and to the difficulty experienced in controlling it. It is possible to open many of these spaces with almost no bleeding and in most cases such bleeding as is present can be controlled by several gauze sponges packed into the cavity and left in place for a short time. Each suture used usually means the loss of 0.5 cm. of skin graft over and around this area. The most troublesome area of bleeding when it does occur is along the hymenal plexus of veins. The loss of continuity in the graft here is nullified by the epithelium of the introitus extending inward to cover this area.

The hollow lucite vaginal mold now in use has been evolved by much trial and error and changes have been dictated by experience. It is of a blunted torpedo shape and is 4 inches (about 10 cm.) long and 1 1/2 inches (about 4 cm.) in its greatest diameter. The proximal 1 1/2 inch (about 4 cm.) is beveled superiorly and inferiorly where it lies under the urethra and over the anal pouch. The distal end is perforated by two 0.3 cm. holes and the proximal end has a 1 cm. button on it which is also perforated for purposes of drainage. This mold fits rather snugly in the vagina of a normal nullipara and if not lubricated is easily retained by the patients without mechanical aid.

The mold is covered with a split thickness skin graft measuring 10 by 4 cm. taken with the Paget dermatome from beneath the breast or from the inner surface of the thigh. The mold covered with skin is placed in the prepared cavity and all areas are smoothed out over it by rotating it several times and by manipulating it from the rectum and through the abdominal wall.

The mold is held snugly in place with an adhesive binder and is left undisturbed for fourteen days. During this time the patient is kept in bed with a retention catheter in place and is given a diet free of residue. Since the operation is performed under pentothal sodium anesthesia very little postoperative nausea is experienced. Seldom more than a minimal amount of discomfort is experienced on the first two postoperative days. The morbidity in our cases averaged less than one day.

On the fourteenth day the mold is removed the cavity is inspected

and irrigated and the mold is replaced. The next two days are devoted to the patient's getting back the strength of her legs, learning to change the mold herself and learning how to take a daily vinegar douche. On the sixteenth day she is dismissed from the hospital.

RESULTS

The results are considered good only when the 4 by 1½ inch (about 10 by 4 cm) mold can be retained posterior to the constrictors of the introitus without discomfort, better than a 95 per cent take of the skin graft has occurred and no single area of loss of continuity of the graft is larger than a dime (about 1.8 cm diameter). Of these thirty-five cases in twenty-five these rigid criteria of good results were met. In an additional four cases the criteria were met only after a second skin graft had been inserted. In one of these four cases weeping generalized dermatitis developed sixteen days after operation and the entire graft was lost. Four years later the cavity was reopened and a good result was obtained with a second graft. This patient's perseverance was inspired by a sister who was subjected to operation at the same time as her own original procedure and who had been happily married for three years. In a second case of the four a small abscess in the vault contributed to the necessity for regrafting. In the other two cases of the four the successful regrafting was necessitated by loss of continuity in the vault, which had allowed contraction and adhesions of the vault making it impossible for the mold to be retained.

In three cases the result was only fair. In one, the vagina will admit two fingers and the depth is 5 inches (about 8 cm); the cavity is completely epithelized but contraction of the vault necessitates the patient using a smaller mold. In one of the three cases depth of the cavity is only 2½ inches (about 6 cm) due to loss of continuity of the graft in the vault, with closure of this space. The third patient of the three was subjected to regrafting with only fair results; the woman has been married for two years and she and her husband find coitus satisfactory but she has not been examined since her dismissal.

In three cases the result was poor at the time of dismissal and the patients have not been re-examined. One of the three patients, although the vault was contracted at the time of dismissal, has been happily married for three years. In the second of the three cases in which operation was performed seven years ago 50 per cent of the skin graft was lost in irregular areas throughout the space. The third patient was dismissed with directions to use a relatively small mold because of contraction of the vault.

We have been greatly concerned about loss of a portion of the graft and have tried various means including regrafting to overcome this difficulty. Loss of a portion of the graft does not often occur but it

can occur and therefore must be reckoned with. There will be no contraction of the vault or of the size of the vagina so long as the original mold remains in position. If the mold is removed for any length of time while the tract is not completely epithelized some contraction will result.

For some unknown reason skin grafts in the vagina will not proliferate or grow on denuded areas as they do on the surface of the body. Up to now it has been necessary to regraft a denuded area. Recently through the co-operation of our colleagues we have found a method that will stimulate these grafts to grow in the vaginal tract. Now therefore when the mold is removed and any loss of the graft is evident or when there is any loss of the graft later by virtue of infection it is possible within a short time for the graft completely to epithelize the vaginal tract. This method will be explained in detail in a later communication.

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BILATERAL ORCHECTOMY FOR CARCINOMA OF THE PROSTATE GLAND PRELIMINARY REPORT

JOHN L. EMMETT AND ROBERT S. HAVIN

THE EXPERIMENTAL work concerning bilateral orchectomy for carcinoma of the prostate gland carried on by Huggins and his associates¹⁻³ is one of the most outstanding contributions to medical science in recent years. It is too soon however to evaluate the ultimate place in surgery of this procedure. It already has been suggested⁴ that the operation may be only one of palliation and that therefore it should be reserved for the terminal stages of the disease. Although this assumption may prove to be correct our feeling is that sufficient data have not yet been accumulated to substantiate it. Up to the present we purposely have published nothing concerning our experience at the Clinic with this procedure because we have felt that our data were not sufficient and that our follow up study was not long enough continued to justify conclusions of any importance. Inasmuch as conflicting statements are now appearing in the current literature in which conclusions are being drawn from obviously too small series of cases and from results of relatively short follow up studies it seemed that a study of our material at this time might be justifiable and possibly of some value.

From June 1 1941 to December 31 1943 inclusive 220 patients with carcinoma of the prostate gland were subjected to bilateral orchectomy at the Clinic. Fifty six of these patients returned for re-examination at some time after operation. An attempt has been made to keep in touch with the remainder by means of follow up letters. In evaluating the data which will be presented here it must be kept in mind that several of the operations concerned have been performed too recently to allow of follow up study.

Of the 220 patients presented in this study 164 (74.5 per cent) gave evidence of metastasis as demonstrated by one or more of the following methods: (1) clinical evidence (pain), (2) roentgenographic demonstration of metastasis to the bones, and (3) elevation of the serum acid phosphatase (5 or more King Armstrong units). Fifty six of the 220 patients gave no evidence of metastasis. Of the 164 patients with metastasis 108* were subjected to transurethral prostatic resection in addition to orchectomy. Of the fifty six patients without evidence of

On thirty of these patients the transurethral resection was done several months or years prior to the orchectomy. On the remainder it was done at or near the same time.

metastasis fifty* were subjected to transurethral resection in addition to orchectomy. A study of this subject naturally divides itself into two problems. First, estimation of the value of castration to patients with metastasis and second, its value to patients with respect to whom metastasis cannot be demonstrated (prophylactic orchectomy).

TABLE 1—DATA CONCERNING 164 PATIENTS WITH METASTASIS FROM CARCINOMA OF THE PROSTATE GLAND

Metastatic Pain Prior to Operation	Immediate Effect of Orchectomy on Pain							
	Excellent Relief		Fair Relief		Poor Relief		Not Noted or Heavy	
	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent
127	76	60	23	22	11	8.6	12	9.4

The 164 patients with metastasis will first be considered as regards the clinical benefit received from orchectomy. The most accurate method of evaluating the benefit is to estimate relief of pain from the metastatic growth, so called *metastatic pain*. Of the patients 127 com-

TABLE 2—DATA CONCERNING 76 PATIENTS WHO OBTAINED EXCELLENT IMMEDIATE RELIEF OF METASTATIC PAIN AFTER ORCHECTOMY

Patients		Patients Living	
Dead	Alive	Free of Pain	Reluctant Pain
9	67	32 N.B. Length of follow up 0-6 mos 6 mos-1 yr 1-1½ yrs Over 1½ yr Total	35 N.B. Duration of relief of pain following orchectomy 6 Not known 15 Few days or weeks 5 Several months 6 0-6 mos 3 6 mos-1 yr 1 1½ yrs 3 Over 1½ yrs Total
			9 2 13 3 4 1 3 35

plained of metastatic pain prior to orchectomy. The immediate results of the operation are noted in Table 1. It appears that approximately 60 per cent of patients experienced excellent relief of pain soon after

On thirteen of these patients the transurethral resection was done several months or years prior to the orchectomy.

operation while another 22 per cent were given some relief. Unfortunately however in many cases the relief of pain proved to be only temporary. This is illustrated by an analysis of the seventy six cases (Table 2) in which excellent immediate relief of pain resulted from orchectomy. It will be noticed that in the large majority of cases the pain recurred within a few months. Only a small number of patients remained comfortable more than a year although six of the patients under consideration here have remained free of pain for more than eighteen months. So far in this study we have detected no means of determining before operation which patients will be relieved of pain or for what period the relief can be expected to continue.

The second important clinical problem is the efficacy of castration in cases of carcinoma of the prostate gland in which evidence of metastasis cannot be demonstrated clinically, chemically or roentgenologically. In the present series were fifty six cases which fall into this category. An analysis of these cases is presented in Table 3. Six (11

TABLE 3—FIFTY SIX PATIENTS WITH CARCINOMA OF THE PROSTATE GLAND BUT IN EXAMINATION OF WHOM EVIDENCE OF METASTASIS COULD NOT BE DEMONSTRATED CLINICALLY, CHEMICALLY NOR ROENTGENOLOGICALLY

Number of Patients Metastasis Mortality	Length of Follow-up—Orchectomy					Total	
	0-6 mos	6 mos-1 yr	1 1/2 yr	Over 1 1/2 yrs	Not followed up		
Number of Patients	6	23	12	9	6	56	
Metastasis has appeared since castration	1	6	0	2	0	Number	Percentage
Dead	0	2	1	3	0	6	11

per cent) of these patients are now dead while nine (16 per cent) have given evidence of metastasis since operation. Two of the patients lived only six months to one year while three lived more than a year after castration. It is obvious that these data are insufficient to warrant any conclusions. When considering the cases in which metastasis appeared however it must be remembered that metastasis may have been present at the time of operation even though it was impossible to detect it. More cases and a longer follow up period will be necessary before the results of this procedure as a prophylactic measure can be evaluated.

Since introduction of orchectomy in this disease the question has been asked if orchectomy alone will relieve symptoms of urinary obstruction so that some form of operation on the prostate gland is ren-

dered unnecessary. In this series sixty-two patients were subjected to orchectomy only. All others were subjected to transurethral resection either at the same time as orchectomy or at some previous time. Of these sixty-two patients twenty-four suffered with definite symptoms of obstruction. In seventeen of these twenty-four cases (71 per cent) there was definite improvement. In the remainder relief of symptoms was not obtained.

The question has been raised whether the prostate gland undergoes regression in size and induration following orchectomy and if so in what proportion of cases do these effects occur. Fifty-six of our patients have returned for re-examination. Concerning only forty-five were there sufficient data on the record to allow of any inference in this regard. In five of the cases regression had been so marked that it would have been impossible from digital rectal examination to make a diagnosis of carcinoma of the prostate gland. In ten more cases regression was definite whereas in the remaining thirty no change as compared with previous examination could be demonstrated (Table 4).

TABLE 4—REGARDING REGRESSION IN SIZE AND CONSISTENCY OF THE PROSTATE GLAND FOLLOWING ORCHECTOMY

Op-er-a-t-ion	I-m-p-r-o-v-e-m-e-n-t		P-a-t-i-e-n-t N-o-t I-m-p-r-o-v-e-d
	Mild Impr-ement No Definite Symp- toms	Advanced Carcinoma	
Transurethral resection and orchectomy	3	3	9
Orchectomy only	2	7	21
Total	5	10	30

Fifty-six patients returned for re-examination. Insufficient data on history and physical examination for study.

Although we have seen some evidence of regression of metastatic lesions in the roentgenograms following orchectomy, it has been of rather infrequent occurrence. Of the fifty-six patients who have returned for re-examination, forty-one had given roentgenographic evidence of metastasis prior to operation. In only three of these cases was improvement noted in subsequent roentgenographic study. In one of them, however, evidence of metastatic lesions in the bone disappeared and the case is of sufficient interest to be described here.

A physician, fifty-five years of age, was admitted to the Clinic December 29, 1941, complaining of severe pain of six weeks' duration which was localized in the right hip and groin. Digital rectal examination disclosed the prostate gland to

be only slightly enlarged. In the right lobe of the gland were several hard firm nodules. There was no question in the mind of the examining urologist but that the growth in the prostate gland was malignant. The value for serum acid phosphatase was only 4.5 King Armstrong units. Roentgenologic studies disclosed metastatic carcinoma involving the tuberosity of the right ischium and destruction of the body of the seventh thoracic vertebra. The concentration of hemoglobin was 14.8 gm per 100 cc and erythrocytes numbered 5,010,000 per cubic millimeter of blood. Bilateral orchectomy was performed January 2, 1942. The patient experienced almost immediate relief of pain.

He returned for re-examination on May 25, 1943, at which time he was feeling well and had no symptoms. Roentgenograms showed that the lesion in the right ischium had entirely disappeared. Compression of the seventh thoracic vertebra had persisted as would be expected. The values of serum acid phosphatase and serum alkaline phosphatase were 1.7 and 7.8 King Armstrong units respectively. On rectal examination the prostate gland felt normal in size and consistency and it would have been impossible at the time of the examination that is under consideration to have made a diagnosis of carcinoma of the prostate gland.

There has been much discussion concerning interpretation of the concentration of acid and of alkaline phosphatase in the blood. It will be recalled that in the beginning of this paper we stated that 164 of our patients gave evidence of metastasis either clinically, chemically, or roentgenologically. By definition we stated that chemical evidence of metastasis was present when the value for serum acid phosphatase was 5 or more King Armstrong units. The alkaline phosphatase was not considered in this definition. The values for acid and for alkaline phosphatase in this group of patients are shown in Table 5. The most

TABLE 5—VALUES FOR SERUM ACID PHOSPHATASE AND FOR SERUM ALKALINE PHOSPHATASE IN CASES OF CARCINOMA OF THE PROSTATE GLAND*†

Metastasis Present or Absent	Kind of Determination				Total
	Normal Acid and Alkaline	Elevated Acid and Alkaline	Elevated Acid but Normal Alkaline	Normal Acid but Elevated Alkaline	
Patients with metastasis	35	53	8	36	132
Patients without metastasis	36	0	0	0	36

Total patients with metastasis = 164

Total patients without metastasis = 56

Phosphatase determinations made = 132

Phosphatase determinations made = 36

† Definition: Acid phosphatase 0-5 King Armstrong units = normal

Alkaline phosphatase 0-10 King Armstrong units = normal

significant finding in this table is that of the 132 patients with metastasis on whom phosphatase studies were made the serum acid phosphatase and serum alkaline phosphatase levels of thirty five were normal. The serum acid phosphatase of still another thirty six patients was normal but the value for serum alkaline phosphatase was elevated. This suggests that almost 54 per cent of patients with metastasis give false negative determinations if the acid phosphatase is considered the determination of importance. Nothing can be deduced regarding false positives as by definition in Table 5 we have regarded a value for acid phosphatase of 5 or more King Armstrong units as indicative of metastasis. Of interest is the fact that thirty six patients with clinical or roentgenologic evidence of metastasis had normal acid phosphatase but elevated alkaline phosphatase values.

In this series we encountered one case of pathologic fracture. It involved the left femur and the fracture healed spontaneously following orchectomy. One patient entered the hospital with complete paralysis of the lower extremities from metastasis to the spinal column. There was no improvement after orchectomy and the patient died within two months. In another case paralysis developed thirty six hours after orchectomy. We have information that paralysis has developed in four more cases since orchectomy was performed at the Clinic. In two of these cases it occurred within nine months, in one within five months and in one within a few months after orchectomy.

Another interesting observation of the results of orchectomy has been the relief of ureteral obstruction caused by extension of the carcinoma to involve the terminal portions of both ureters. The case now to be reported is illustrative.

A carpenter fifty four years of age first came to the Clinic in July 1940 because of urinary obstruction caused by a carcinoma of the prostate gland. There was no evidence of metastasis. The concentration of blood urea was 34 mg per 100 cc and residual urine measured more than 150 cc. Transurethral resection was performed July 10. Tissue weighing 34 gm was removed. The pathologist's diagnosis was adenocarcinoma grade 2. Following the resection, the man was given a course of roentgen therapy. He was dismissed from the Clinic in good condition, he could void well and empty his bladder completely.

The man returned to the Clinic eight months later (December 1941) stating that recently he had seen blood in his urine. He was given stilbesterol and was advised to take 1 mg daily on alternate weeks.

In May 1943 the patient returned again complaining that he didn't feel well. He was voiding normally and the rectal examination disclosed only 20 and 40 cc of residual urine on two examinations. On rectal examination the entire pelvis was frozen with a huge malignant mass. The concentration of blood urea was 156 mg per 100 cc and that of blood creatinine 6.0 mg per 100 cc. The values for acid phosphatase and alkaline phosphatase were 5.4 and 15.1 King Armstrong

units respectively. There was no evidence of metastasis on roentgenologic examination.

The patient was hospitalized and drainage by urethral catheter was instituted. The urinary output was about 2000 cc daily but the urine was of very low specific gravity and after several days drainage the concentration of urea did not fall. Bilateral orchectomy was then done. The catheter was removed two days later. On the fourth postoperative day the value for urea was 107 mg per 100 cc. of blood and by the tenth postoperative day it was 92 and the concentration of blood creatinine was only 2.2 mg per 100 cc. The patient felt much improved and was dismissed. A letter received from the patient two months later stated that he was in excellent health.

It is difficult in a study of this kind to place much reliance on such poorly measured data as improvement in patient's general health and increase or decrease in weight. This is especially true when most of the follow up information is obtained from letters of inquiry. For this reason we have not given such data statistical consideration here. Nevertheless improvement of a patient's general health and well being occasionally is more striking than is his improvement in other ways that can be more accurately measured. The following case is exemplary.

A railroad brakeman sixty years of age first came to the Clinic in July 1937 because of symptoms of urinary obstruction which were found to be caused by a carcinoma of the prostate gland. Residual urine measured 1600 cc. The concentration of blood urea was 37 mg per 100 cc and there was no evidence of metastasis. Transurethral resection was performed July 10. The tissue removed was reported to be characteristic of adenocarcinoma grade 3. The man was dismissed in good condition; he could void well and could completely empty his bladder.

He returned two years later with recurrence of his symptoms of obstruction. There was still no evidence of metastasis. Transurethral resection again relieved his trouble.

In two years more (May 1941) the patient returned again complaining of recurrent symptoms of obstruction but in addition he complained of loss of weight, loss of strength and anorexia. There was still no evidence of metastasis, however. A third resection, as performed on May 14. This again relieved the urinary obstruction. However the man returned seven months later and was visibly failing. He had lost 30 pounds (about 14 kg) in the past few months and he had no appetite. Recurring symptoms of obstruction were beginning to develop. Bilateral orchectomy was done. Three months later the patient's wife came to the Clinic to report that her husband had regained most of his weight, had an excellent appetite, was working every day and had perfect vesical function. He was obliged to urinate only once a night.

The problem of the comparative value of estrogenic therapy and orchectomy is still unsettled in our minds. Our impression is that orchectomy yields more dramatic and immediate results. Nevertheless

an occasional case is encountered in which almost brilliant results are achieved with stilbestrol or some other form of estrogenic therapy. The following case is illustrative.

A man forty three years of age was admitted to the Clinic on February 15, 1943 complaining of severe pain in the left thigh. The pain had been present for almost eight months. A roentgenogram of the region of the kidneys ureters and bladder disclosed extensive metastatic destruction of the left innominate bone, the left ischium and of the ramus of the pubis. On rectal examination the left lobe of the prostate gland was very firm and there seemed little doubt of the diagnosis of carcinoma of the prostate gland. The values for serum acid phosphatase and for serum alkaline phosphatase were 19 and 246 King Armstrong units respectively. A palliative course of roentgen treatment consisting in two front fields and two flank fields to the pelvis each of which received a dose of 500 r of 700 k filtered through 0.75 of copper and 1 mm of aluminum at 50 cm target skin distance.

The patient returned for reexamination three months later. He stated that he was comfortable and free of pain. The clinical course showed no significant loss of weight. Following roentgenologic studies disclosed progression of the stromal metastasis which now involved the innominate bones. The values for serum acid phosphatase and for serum alkaline phosphatase were 23 and 184 King Armstrong units respectively. Stilbestrol in a dose of 5 mg was administered daily.

The man returned five months later (October 12) for reexamination. At this visit he stated that he was in excellent health free of pain and was doing his regular work. There had been no loss of weight. On digital rectal examination the prostate gland was small and cystic and it would have been impossible from this examination to have made a diagnosis of carcinoma of the prostate gland. There had been marked reduction in level of phosphatase (serum acid phosphatase and serum alkaline phosphatase 10 and 48 King Armstrong units respectively). The patient only palpated a mass of nodes of the breasts distal of the umbilicus. He had not been bothered by this situation.

We have observed several cases in which orchectomy has given relief when estrogenic therapy has failed. We have also encountered a few cases in which the patient seemed to receive some relief from estrogenic therapy after orchectomy had failed. Results in these latter cases however are not at all dramatic and in most cases the improvement has been partial or so incomplete that it has been difficult to evaluate accurately. It is apparent that the most important part of this complex problem is still unanswered. Should estrogenic therapy or orchectomy be instituted as soon as the diagnosis of carcinoma of the prostate gland is made regardless of the presence or absence of metastasis? Stated another way, Will estrogenic therapy or orchectomy retard the progress of the disease regardless of its stage of development? We are anxiously awaiting the time when we can evaluate the results of the so called prophylactic orchectomy which with the full understanding and con-

sent of the patients we have done in cases in which there was no evidence of metastasis. We have placed a large number of patients without metastasis on estrogenic therapy and we are also awaiting the final evaluation of this method of treatment. Until the results of this study are complete we shall keep open minds on the subject.

We wish to emphasize what we hope we already have made clear, namely, that the entire study reported here is not a basis for conclusions of any kind.

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SURGICAL TREATMENT WITH RECOVERY IN A CASE OF PERINEO ABDOMINAL SHOTGUN WOUNDS FROM CLOSE RANGE WITH MULTIPLE INJURIES TO VISCERA

B MARDEN BLACK

AS A RULE all penetrating wounds of the abdomen should be explored. It has been proposed recently, however, that certain small stab wounds of the upper part of the abdomen, lower part of the thorax and renal regions be regarded as exceptions to this rule, as well as penetrating wounds of any part of the abdomen of more than thirty-six hours' duration.⁴ As Oberhelman and Le Count pointed out, shotgun wounds differ sufficiently from other gunshot wounds so that they probably should not be included in the same category with them, and there is a definite tendency at present to treat shotgun wounds of the abdomen produced at a distance without exploration.

For small stab wounds of the upper part of the abdomen, lower part of thorax and renal region, the risk of laparotomy is said to be greater than the risk of the wound. In the first place, many stab wounds of the abdomen do not involve any of the viscera. Martin⁵ failed to find injury to viscera in thirty-one of fifty-seven such cases on exploratory operation. Wangenstein⁶ reported that incisions up to 1 cm. in length made in the empty stomach of the usual laboratory animal was tolerated without mortality if the stomach was kept empty. If the stomach was full, however, the mortality rate was found to be 88 per cent. Bleeding from small stab wounds of the liver or kidneys tends to stop spontaneously, and the ability of the surgeon to further this process is limited. Bleeding from lacerations of the spleen is somewhat more dangerous, but adequate evidence of continued bleeding may be obtained from physical examination or from plain roentgenograms of the abdomen. While it is accepted that the need for exploration of such wounds is less urgent than with other penetrating wounds, it is probable that most small stab wounds in the upper part of the abdomen are explored primarily.

The time factor is of extreme importance in the management of penetrating wounds of the abdomen. After peritonitis has become established, little can be expected from operation, and the chances of harming the patient are great. In this connection, Counsellor wrote that probably few patients would be saved by operation after the lapse of thirty-six hours. If the patient is recovering after this lapse of time, laparotomy is not indicated, and the only surgical procedures that

should be carried out are for drainage of abscesses closure of secondary perforations or stopping of secondary bleeding

The third exception to the rule of exploration pertains to shotgun wounds. When the wound has been produced by shot fired from sufficient distance so that the shot have had time to separate the multitude of perforations almost defy surgical repair and the surgical trauma necessary to find and repair them probably would harm the patient more than the repair would benefit him particularly since the tiny perforations will heal spontaneously if the bowel is not traumatized. Bunch¹ wrote that while patients with such wounds should be explored nothing should be done surgically to the tiny perforations in the bowel and Willis⁷ proposed that conservative management was definitely better than surgical exploration. Shotgun wounds from close range usually are hopeless because of the extensive damage produced by the charge. Entire segments of the body wall often are destroyed and the damage to the underlying viscera is often so extensive that surgical repair is out of the question. Shock is likely to be marked and results not only from damage to viscera but also from extensive bleeding since major vessels are likely to be opened.

Apart from these exceptions abdominal exploration of all penetrating wounds is imperative as soon as the patient is in shape for operation. Shock must be combated by means of transfusions of blood or serum preferably the former because loss of blood is usually an important factor in the production of shock. The more blood that is necessary to restore the systolic blood pressure to a level of 80 to 90 mm. of mercury the more certain it is that loss of blood has been extensive and the chances of recovery of the patient are correspondingly less. The anesthetic agent of choice is ether although local anesthesia has been used for occasional stab wounds. The incision should be adequate and right angled extensions of the original incisions are often necessary to secure exposure. Attention should be directed first to the bowel and the search for perforations must be meticulous since if any are overlooked peritonitis probably will result. How frequently perforations are overlooked is indicated by the fact that of 169 patients who died after surgical exploration because of gunshot wounds Oberhelman and Le Count reported that missed perforations were present in ninety four. Small perforations of the bowel may be closed by a single or double row of Lembert or Cushing sutures but more extensive lacerations require resection. Damage to the mesentery may make resection necessary also. Extensive wounds of certain segments of the colon often can be treated safely by exteriorization and there is wide agreement that proximal enterostomy is of great benefit in the management of wounds of the lower part of the ileum and colon. Perforations of the bladder can be closed readily as a rule and

it usually is a safe plan to establish suprapubic drainage. Comparatively little can be done surgically to lacerations of the liver. Lacerations of the spleen other than the minor ones probably should be treated by splenectomy.

The prognosis in penetrating wounds of the abdomen depends on the number and kind of viscera injured, on the time between the injury and treatment, on the amount of hemorrhage and finally on the success of the surgeon in finding and repairing the visceral injuries. The prognosis after stab wounds is best because visceral injury is less and also because infection is not spread widely throughout the peritoneal cavity as in gunshot wounds when the bowel has been perforated. Similarly, wounds produced by bullets of large caliber are more dangerous than those produced by bullets of small caliber. Shotgun wounds from close range carry the highest mortality rate because of the number of viscera injured and the extent of the injury to them because bleeding is likely to be pronounced and because adequate surgical repair frequently is out of the question. Most of the published reports of shotgun injuries to the abdomen produced at close range deal with single patients who recover so that it is not possible to estimate the mortality rate of such wounds with accuracy except to point out that recovery is exceptional. Oberhelman and Le Count reported that in their series of 301 cases of laparotomy because of gunshot wounds of the abdomen the mortality rate when two or more viscera were injured was 80.7 per cent.

Recently a patient suffering from a perineo abdominal shotgun wound produced at short range who had extensive damage to viscera was treated at the Clinic.

REPORT OF CASE

The patient, a boy eleven years old, was brought to the Clinic by the physician in his home locality for treatment of a shotgun wound sustained eight hours before. The patient was climbing up the side of a corn crib when the shotgun he was carrying (gauge 410) slipped and struck him first on the concrete floor. The jar dislodged the gun and the charge (7 or 7½ shot) struck the perineum from a range of probably less than 1 foot (30 cm). There were no wounds of exit. The entire charge apparently had entered the abdomen through the perineum. Anteroposterior and lateral plain roentgenogram of the abdomen demonstrated many shots in the perineum and abdominal cavity (Fig. 359 a and b) and on catheterization frank blood but no urine was obtained from the bladder. During the trip to the Clinic by ambulance pain was controlled adequately by morphine sulfate. About an hour before arrival the patient's condition became precarious and caffeine benzoate was administered intravenously. His condition improved somewhat and the journey was continued.

On arrival at the Clinic the patient was obviously in shock. His systolic blood pressure was 65 mm. of mercury and the pulse rate was 180 beats per minute. The heart and lungs seemed essentially normal. The abdomen was moderately

distended was dull to percussion and was everywhere exquisitely tender. The wound of entrance was situated just to the right of the anus and measured approximately 5 cm in diameter. It was evident that extensive intra abdominal injuries were present and that exploration should be carried out as soon as the condition of the patient could be improved sufficiently. He was given 500 cc of whole blood intravenously. The signs of shock decreased rapidly and the systolic blood pressure rose to 95 mm of mercury during the course of the transfusion.

It was decided that the condition of the patient was satisfactory enough to permit exploratory operation and this was undertaken through a lower right rectus incision with the patient under ether anesthesia. The peritoneal cavity con-



Fig 359—The number of shot that reached the abdominal cavity *a* Anteroposterior view *b* lateral view

tained at least 2 000 cc of bloody uncoagulated fluid which was evacuated. There was one perforation in the anterior wall of the bladder just above the trigone which measured approximately 4 cm in diameter and a second opening of similar size in the dome of the bladder. There were many (ten to fifteen) small perforations with protruding mucosa in the ileum and jejunum and two segments of the ileum each approximately 15 cm in length and about 50 cm apart were literally in shreds (Fig 360). Injury to the cecum, the stomach, transverse or sigmoid segments of the colon was not found. Each of the small perforations in the bowel was repaired by means of a single row of serosal sutures. A segment of the most damaged part of the ileum which measured 130 cm in length was removed and the continuity of the bowel was restored by means of a side to side anastomosis. The rent in the dome of the bladder was repaired and a No 26 F catheter was sutured into the opening in the anterior wall of the bladder.

and brought out through a supra pubic stab wound. Two Penrose drains were left in the peritoneal cavity and a third in the space of Retzius. The patient tolerated the procedure well and the systolic blood pressure at the conclusion of this part of the operation was 105 mm.

The patient was then placed in the lithotomy position and debridement of the wound of entrance in the perineum was performed. The wound was packed open fully with iodoform gauze. Fifteen grams of sulfathiazole was left in the peritoneal cavity at the conclusion of the operation and another 5 gm. was left in the space of Retzius. A prophylactic dose of polyvalent gas gangrene and

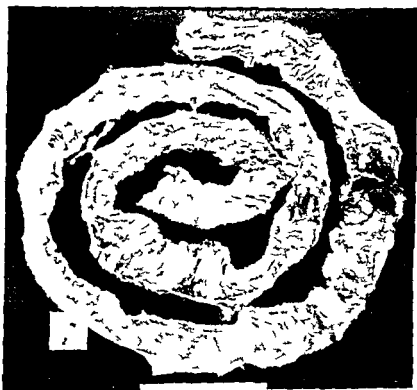


Fig. 360—The resected segment of ileum. The two areas of tensed damage are well illustrated. The damage to the mesentery is not shown.

tetracycline antitoxin was administered. A second transfusion of 500 cc. of whole blood was administered during the course of the operation. It is possible to reconstruct the core of the charge with some certainty after debridement of the perineal wound. The patient had entered just to the right of the anus and coursed inferiorly to impinge against the inferior ramus of the pubis and dorsal surface of the symphysis pubis (Fig. 361). It had coursed through the bladder producing the two wounds previously mentioned and had then settled in the region occupied by the small intestine. It is probable that most of the force of the charge was absorbed by the pubis.

Course—A third transfusion of 500 cc of blood was given approximately four hours after the conclusion of the operation. Evidence of peritonitis subsided rapidly and the patient passed gas and had a bowel movement on the sixth day following the operation. The suprapubic catheter became occluded on the eighth day after operation and was replaced without incident. The suprapubic catheter was removed about two weeks after operation. The wound healed rapidly and the bladder was kept empty by means of a urethral catheter. Low grade fever of from 99 to 101 F continued for approximately three weeks but finally subsided. The patient was dismissed from the hospital the fifth week following the operation.

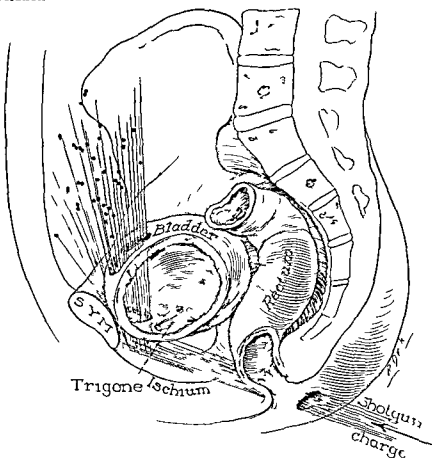


Fig 361—The course of the charge of shot. It is evident that most of the intra peritoneal damage is produced by shot deflected by the pubis.

After the patient's dismissal from the hospital his progress was satisfactory for about three weeks before it became evident that a urethral stricture was developing. The patient passed a good deal of urine through the unhealed perineal wound and practically none through the urethra. After unsuccessful attempts at instrumentation a suprapubic cystostomy was carried out on May 17 1943 and it was possible with the bladder open to insert sounds through the urethra and later to pass a No 16 F catheter. The suprapubic opening was kept open for approximately a month when the tube was removed and the fistula was allowed to close.

On cystoscopic examination following the dilatation it was found that the right half of the bulbous urethra had been injured and that the stricture had developed in this region. Repeated urethral dilatations were carried out until ultimately the stricture showed no tendency to reform. The patient was last seen at the Clinic in December 1943 at which time the stricture had not returned for approximately two months the urinary stream was of good size and the patient had normal control.

COMMENT

The satisfactory outcome of any shotgun wound of the abdomen from close range is unusual and in this case probably should be attributed to the fact that a good part of the force of the charge was absorbed by the pubis. It was most fortunate and almost incredible that the rectum, the trigone of the bladder and the ureters escaped injury. The prolonged course of the treatment following the injury was necessary because of the urethral injury with subsequent scarring which responded ultimately under conservative management. The satisfactory response of the peritonitis the result of extensive intraperitoneal contamination by contents of the ileum to the massive dose of sulfathiazole given intraperitoneally was most gratifying.

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DIAGNOSIS AND SURGICAL TREATMENT OF GLOSSOPHARYNGEAL NEURALGIA

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Glossopharyngeal neuralgia is a major type of neuralgia occurring in the distribution of the ninth cranial nerve. For a time there was much uncertainty as to whether or not this condition existed as a distinct clinical entity. Today, however, among neurologists and neurosurgeons there is complete accord as to its existence and its clinical manifestations are well known. Likewise, the curative treatment has been well established since publication of Adson's paper on "The surgical treatment of glossopharyngeal neuralgia" in 1924. Important contributions to the subject were made by Weisenburg in 1910, Sicard and Robineau in 1920, Harris in 1921, Doyle in 1923, Adson in 1924, Dandy in 1927 and Peet in 1935.

SYMPTOMATOLOGIC ASPECTS

Glossopharyngeal neuralgia is a rare type of neuralgia and is not encountered with anything like the frequency of the better known and more easily recognized types of neuralgia. The symptoms of glossopharyngeal neuralgia, however, are fully as typical as those of trigeminal neuralgia. The severe pain occurs in paroxysms and between attacks the patient is comfortable and able to go about his normal activities without disturbance. The paroxysms are sudden in onset and the pain, which usually extends from the region of the tonsillar fossa of the affected side to the homolateral ear, is exquisite. During an attack the patient usually becomes immobile and is unable to talk, chew or swallow until the paroxysm has disappeared. Immediately thereafter he may appear to be perfectly normal and in good health unless considerable loss of weight has resulted from his inability to eat. The paroxysms usually are brought on by chewing, swallowing and yawning. The examiner may produce an attack by irritating the trigger zone in the tonsillar fossa of the side affected. Results of neurologic examination are negative and the pharynx and larynx are free from objective evidence of disease.

DIFFERENTIAL DIAGNOSIS

Glossopharyngeal neuralgia must be distinguished from *trigeminal neuralgia* which it sometimes simulates. In fact, in earlier cases glossopharyngeal neuralgia was considered to be atypical trigeminal neuralgia. In trigeminal neuralgia the flashes of pain extend over one or more of the three terminal branches of the fifth cranial nerve. The pain is

more likely to be precipitated by exposure of the face to cold air or cold water and by the act of shaving. The pain of trigeminal neuralgia however may be brought on by chewing and swallowing so that if the third branch is involved the clinical picture may simulate that of glossopharyngeal neuralgia. In doubtful cases the differential diagnosis can be established by cocainization of the throat of the patient on the side involved. This anesthetizes the trigger zone of glossopharyngeal neuralgia and during the period of anesthesia the patient will be free of paroxysms of pain so that the examiner will be unable to initiate an attack by irritation of the tonsillar fossa. If on the other hand the pain is trigeminal in origin cocainization of the throat of the patient will be without effect in prevention of the paroxysms. The injection of procaine hydrochloride or alcohol into the suspected branch of the trigeminal nerve will relieve trigeminal neuralgia but will have no influence on the pain of glossopharyngeal neuralgia.

Another and more rare type of neuralgia which may be confused with the glossopharyngeal type is *neuralgia of the superior laryngeal nerve*. Because of the physiologic and anatomic anastomosis and close association of the glossopharyngeal and vagus nerves the pain of neuralgia of the superior laryngeal nerve may suggest glossopharyngeal involvement.⁷ The pain of neuralgia of the superior laryngeal nerve is severe lancinating and paroxysmal just as is that of trigeminal and glossopharyngeal neuralgia but the pain in superior laryngeal neuralgia centers chiefly in the neck rather than in the face or throat. The pain is centered chiefly over the hyothyroid membrane and this structure is likely to be very tender on palpation. The trigger zone of neuralgia of the superior laryngeal nerve is situated in the pyriform sinus of the affected side. Cocainization of this sinus will serve to distinguish this type of neuralgia from the other major types of neuralgia of the face and throat.

TREATMENT

There is no specific medical treatment for glossopharyngeal neuralgia. During an attack the patient should remain in a quiet well heated room and sedative agents for neuralgia may be administered. Administration of morphine sulfate may be required to relieve the pain. Since the disease is chronic and recurrent opiates should be administered with extreme care and should not be administered for a long period lest addiction develop. Whereas in trigeminal neuralgia the injection of alcohol into the fifth cranial nerve will produce good palliative relief for many months this method of treatment is not advocated for glossopharyngeal neuralgia. The ninth cranial nerve because of its relationship to the great vessels of the neck and to the tenth and eleventh cranial nerves does not lend itself to such treatment. Diffusion of the alcohol might result in severe complications.

Peripheral avulsion of the nerve which was advocated and practiced until Adson recommended intracranial section of the nerve in 1924 is a procedure which will result in relief but if the nerve is not divided between the superior ganglion and the medulla regeneration may occur causing recurrence of the paroxysms of pain. Peripheral avulsion is a tedious time consuming operation which requires meticulous dissection of the structures of the neck and which may be followed by recurrence of the neuralgia.

The treatment of choice and the one which produces excellent results is that recommended by Adson in 1924 and carried out by him in 1925 namely intracranial section of the involved ninth cranial nerve in advance of the point at which it enters the jugular foramen. This operation can be performed with little risk through unilateral suboccipital craniotomy. If the patient is old, debilitated or dehydrated a period of preoperative preparation in the hospital is advisable. The administration of fluids by vein or by hypodermoclysis may be required and sedation sufficient to insure the patient restful sleep should be utilized so that the patient may be in the best possible condition for operation. Some patients come to the surgeon seeking permanent relief of their distressing pain after they have spent many sleepless nights and have eaten very little because of their fear of producing more paroxysms of pain on chewing and swallowing.

The operation has no distressing sequelae. The sensory distribution of the ninth cranial nerve is so limited that the patients are not usually conscious of any numbness in the throat and it is with difficulty that anesthesia can be demonstrated on neurologic examination. Paralysis of the stylopharyngeus muscle which results from sectioning of the motor portion of the ninth cranial nerve causes no difficulty. On close inspection the examiner may notice slight deviation of the uvula from the midline but the patient is not conscious of this slight change.

REPORT OF CASE

The patient was a white man twenty nine years old. He had been referred to the Clinic with a diagnosis of glossopharyngeal neuralgia. The patient said that five months prior to his registration at the Mayo Clinic he had experienced the onset of sharp shooting pain which seemed to begin inside the mouth near the angle of the jaw on the right and to extend up to the ear. The pain he said was brought on by any motion of the tongue, expectoration and by eating. He stated that his throat had been "painted" elsewhere but that relief had not ensued. The patient had had typhoid fever in childhood and influenza in 1918. He also had had tonsillitis for which he had undergone tonsillectomy. He made no other complaints.

General physical examination revealed a well nourished and well developed young man. Vision was 6/6 in the right eye and 6/7 in the left. The pupils reflexes and fields were normal and examination of the fundi revealed nothing abnormal. Results of neurologic examination were objectively negative. Both

corneal reflexes were present and active. Hearing was normal bilaterally. Cannulization of the right tonsillar region gave the patient considerable relief from his pain but did not relieve it entirely. I concurred in the referring physician's diagnosis of glossopharyngeal neuralgia involving the right nerve and advised intracranial section of the ninth cranial nerve on the right side.

A right unilateral occipital approach to the ninth cranial nerve was employed. The right cerebellar hemisphere was gently elevated and the ninth nerve was identified and divided without incident. On awakening from anesthesia the patient was free of the jabs of pain of which he had complained in the distribution of the right glossopharyngeal nerve. The incision healed by primary intention. The patient was dismissed from the hospital on the tenth postoperative day and from my care thirteen days after intracranial section of the nerve. At that time results of neurologic examination were essentially negative and the patient was free of any sensory loss within the pharynx. He did not note any loss of taste.

COMMENT

This patient was operated on approximately seven years ago and since that time he has had no return of his paroxysms of pain. His condition was more or less typical of that of other patients suffering from glossopharyngeal neuralgia whom I have seen except for the fact that this particular patient was much younger than the majority of patients who suffer from this disease. Glossopharyngeal neuralgia like trigeminal neuralgia ordinarily has been considered to be a disease of the later decades of life.

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DIPLOMYELIA AND COMPRESSION OF THE SPINAL CORD AND NOT OF THE CAUDA EQUINA BY A CONGENITAL ANOMALY OF THE THIRD LUMBAR VERTEBRA

GEORGE F. MARR AND ALFRED UHLEIN

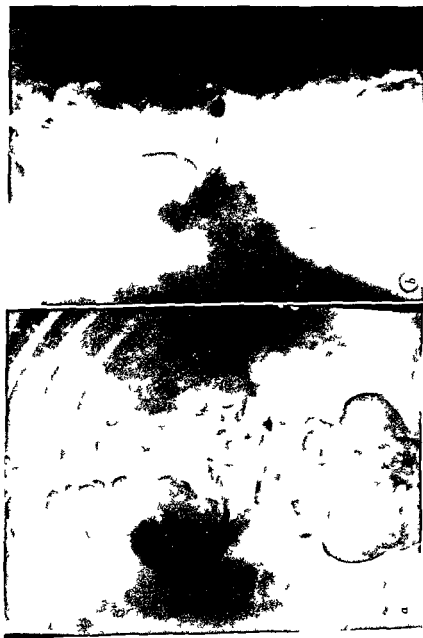
THE SPINAL CORD of adult persons usually terminates at the lower border of the twelfth thoracic vertebra but at birth it is at the level of the third lumbar vertebra. Among adults therefore compression of the spinal cord at the level of the third lumbar vertebra is possible only if the cauda equina is shortened or some other anomaly occurs so that the conus medullaris cannot ascend to the level of the first lumbar vertebra. In the case we are to present an anomaly of the latter nature was present.

Diplomyelia or duplication of the spinal cord which is a rare congenital anomaly was encountered in this case also. Herren and Edwards¹ reviewed the literature and found forty two authentic cases of duplication of the cord. In only two of these was the diagnosis of diplomyelia made during the life of the patient. These authors found that the condition frequently was associated with spina bifida occulta and clubbed feet; half of the cases occurred among adolescent patients. It often was discovered at necropsy in cases in which any clinical evidence of malfunction of the nervous system was lacking. If malfunction had been present the neurologic signs were usually few and could not be attributed definitely to duplication of the cord. In a quarter of the cases of diplomyelia reported by Herren and Edwards an associated osseocartilaginous or osteochondromatous spur continuous with the dorsal aspect of one of the vertebra was found. The assumption is that the diplomyelia is a primary malformation and the associated abnormalities including the cartilaginous processes between the halves of the cord are secondary to the congenital anomalies of the spinal cord.

REPORT OF CASE

The patient, a girl twelve years old, registered at the Clinic on July 28, 1943. The child's paternal aunt had upper thoracic kyphosis and scoliosis associated with club feet and spastic gait. The patient's developmental history was significant in that her birth had been a high forceps delivery after difficult labor. Paralysis of one side of her face had been present for six months after birth. At three months of age a prominence was noted in the lumbar portion of the spinal column. This was associated with loss of the normal lumbar curve and a slight upward tilt of the left side of the pelvis. The lumbar prominence gradually became less noticeable and caused no difficulty other than inability to hyperextend the vertebral column as well as other children.

The patient's main complaint was limping with the left leg which began after a febrile illness in November 1941. At that time she also was unable to



stand on tiptoe or to roll her skate backwards of the weakness of her left foot and ankle. The left lower extremity was hyperesthetic to cold. These symptoms had progressed slowly but steadily. In addition the patient had noticed pruritus

sistent numbness in the left great toe for approximately one month previous to registration. The patient stated that she had experienced some vesical incontinence and at times retention of urine.

Physical findings other than those related to the neuromuscular and skeletal systems were irrelevant. Neurologic examination revealed slight atrophy of the left gastrocnemius muscle, steppage and lumping gait and definite muscular weakness of the whole left lower extremity. The toes could not be dorsiflexed and there was questionable weakness of the muscles of the right foot and toes. The patellar reflex was increased bilaterally. The Achilles reflex was absent on the left side but normal on the right. The left great toe was slightly hypesthetic. In addition there was right thoracic left lumbar scoliosis with flattening of the lumbar curve.

Laboratory studies revealed 13.5 gm of hemoglobin per 100 cc of blood. Leukocytes numbered 9900 and erythrocytes 3,800,000 per cubic millimeter of blood. Urine was normal and the sedimentation rate of erythrocytes was 9 mm in one hour by the Westergren method. Flocculation test on the blood was negative for syphilis. Roentgenogram of the thorax revealed fusion of the right third and fourth ribs posteriorly. Roentgenogram of the lumbosacral vertebrae showed congenital anomaly of the lumbar and sacral vertebrae. This consisted of fusion of the third, fourth and fifth lumbar vertebrae, hemivertebra of the second lumbar vertebra, sacral spina bifida occulta and lumbar scoliosis and kyphosis (Fig 36 a and b). Clinically a definite diagnosis could not be made. Therefore analysis of the spinal fluid and contrast myelography were deemed advisable.

A spinal puncture needle was introduced into the lumbosacral interspace and entered the subarachnoid space without difficulty. A slow drip of slightly cloudy, colorless cerebrospinal fluid was obtained under 1 cm of pressure (pressure is measured as centimeters of water). There was no alteration in pressure or rate of flow on jugular compression. Because of these abnormal results a second needle was introduced into the first lumbar interspace and a slow drip of clear, colorless cerebrospinal fluid was obtained under 6 cm of pressure. On jugular compression the hydrostatic pressure rose to 14 cm and quickly returned to 6 cm on release of the jugular compression. At this point 3 cc of radiopaque oil (pantopaque) was introduced into the subarachnoid space through the upper needle and allowed to flow caudally. On roentgenoscopic examination the subarachnoid space was seen to be partially obstructed opposite the third lumbar vertebra at which point the column of radiopaque oil was narrowed and displaced toward the left apparently by a space-occupying mass which arose from the right side of the vertebral canal. Below the third lumbar vertebra the spinal canal appeared flattened and the nerve roots abnormally prominent, unlike the findings in a lesion of the cauda equina (Fig 363 a and b). Following these studies roentgenograms were made. Then 90 per cent of the radiopaque oil was removed through the lower spinal puncture needle.

The roentgenologic findings suggested a partial subarachnoid block by an intraspinal lesion. The total protein content of the cerebrospinal fluid was 30 mg per 100 cc.

On the basis of the roentgenographic findings surgical intervention was advised. On August 11, 1943, under intratracheal ether anesthesia a bilateral laminectomy was carried out with removal of the spines and laminae of the first and second lumbar vertebrae. On uncovering the dura mater we found normal pul-

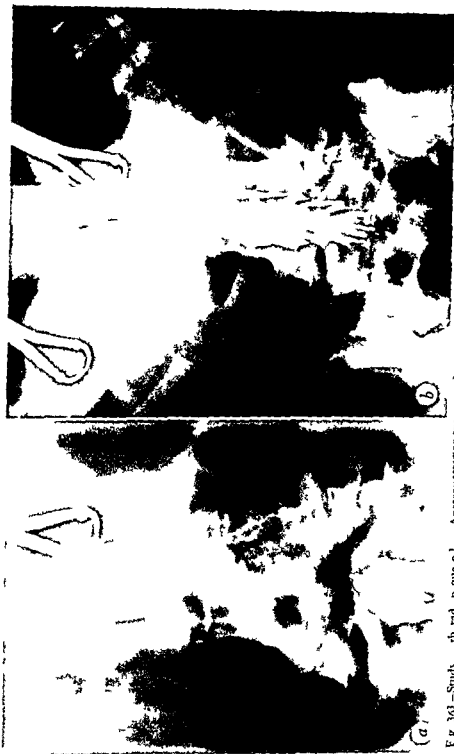


Fig 363—Study
 (a) Anteroposterior view med um, p ss g d tall only on l fr d t b op
 (b) Anteroposterior view med um, p ss g d tall only on l fr d t b op

sations. The dura mater and arachnoid were opened and no intradural mass could be seen. However, instead of identifying the filaments of the cauda equina, we encountered spinal cord. It was bifid for a distance of 4 cm. The two halves of the cord lay lateral to each other with a common dural covering. A rubber



Fig 364—Spicule of bone removed from spinal canal at operation

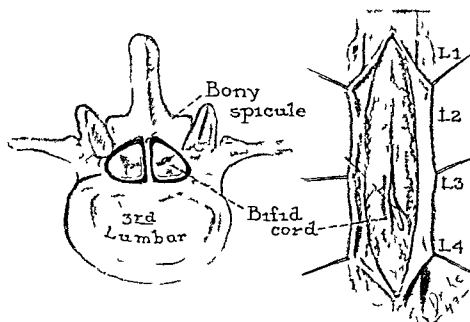


Fig 365—Anatomical drawings of operative findings

catheter 10 F. was passed up the subarachnoid space and encountered no obstruction. On passing it distally, an obstruction was encountered on the right side opposite the third lumbar vertebra. On the left the catheter passed readily to the dural cul de sac. It was evident that the conus medullaris was below this

level. On removing half of the spinous process and lamina of the third lumbar vertebra the obstruction was found to be a bony spicule about 1 inch (2.5 cm.) long which was attached dorsally to the spinous process of the third lumbar vertebra (Fig. 364). The spicule pierced the dura and was directed ventrally between the two portions of the cord and was attached to the ventral surface of the spinal canal. The diplomyelia began at this point and ascended for a distance of 4 cm. Above as well as below this duplication the spinal cord appeared normal (Fig. 365).

The bony spicule was removed with a rongeur. This removed all obstruction in the subarachnoid space. Bleeding was controlled and the dura mater was closed. The wound was closed in layers.

The patient's postoperative convalescence was uneventful. No urinary retention developed and by the third postoperative day she stated that her left leg felt much improved. Slight dorsiflexion of the left toes was now possible. She was out of bed on the twelfth postoperative day. At the time of her dismissal from the hospital on the fifteenth postoperative day there was considerable strength on dorsiflexion of the toes of the left foot. The Achilles reflex on the left side could now be obtained though the Achilles reflex on the right was slightly less active than it had been.

Leather straps were applied to the patient's shoes to support the ankles and prevent pronation. The patient was finally dismissed from our care on the thirty-first postoperative day.

In a recent communication the patient's mother stated that the child could walk without the shoe braces and that the limp was barely noticeable. The patient is in school and is partaking of some athletic activities.

COMMENT

From the surgical findings and operative result we believe the osseous process could have been responsible for the clinical findings. The spicule was probably producing pressure and exerting traction on the cord, the result of skeletal changes associated with adolescence. No clinical evidence of an Arnold Chiari deformity was noted. Removal of the process has produced marked improvement in the patient's condition.

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BARNARD FREE SKIN AND CANCER
HOSPITAL NUMBER

St Louis

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THE SURGICAL CLINICS of NORTH AMERICA

BARNARD FREE SKIN AND CANCER HOSPITAL NUMBER

SYMPOSIUM ON CANCER

INTRODUCTION FOCUSING THE CANCER PROBLEM FOR SURGEON AND LAYMAN

M G SEELIG MD FACS*

THE preparation of this volume of *The Surgical Clinics of North America* has been peculiarly a labor of interest to all therein concerned because it re-emphasizes the significance and importance of cancer research and as is clearly manifest in these combined efforts it demonstrates that cancer research is not a discipline limited to the ivory towers and magnificent isolation of laboratories. The clinic plays a role so significant as to make invidious all comparisons between so-called academic research on the one hand and clinical studies on the other. The nexus between these two is so close and so tight that he would be hard put to it who attempted to prove that either the clinic or the laboratory played the larger role in the notable advances that have taken place in our knowledge of cancer in the last 25 years.

One need strain neither imagination nor credulity in order to bolster the belief that from just such efforts as are mirrored in these joint laboratory and clinical studies there may be extracted the highest hope, the most optimistic faith that we are traveling the road toward the solution of the cancer problem. Oh yes! the path may be and indeed it is devious and winding with blind alleys here and there and with unilluminated stretches that make the going difficult and uncertain but behind us there are clearings where previously had been almost impenetrable tanglewood.

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This spirit of optimism need not postulate a single or multiple causes for the disease it need not posit a basic chemical physical or mechanical agency at work it need not feel the inhibiting clutch of doubt that has been expressed at times even by recognized cancer experts Such presumptions are *merely a priori considerations* that may or may not have significance depending upon their accurate fit in the jigsaw puzzle in process of solution In the end cancer as a problem will be solved by only one technic and that will be the one laid down in the admonition of Thomas Henry Huxley to sit down before fact as a little child be prepared to give up every preconceived notion follow humbly wherever and to whatever abysses nature leads or you shall learn nothing And that is exactly what qualified cancer investigators throughout the world are doing in laboratories in wards in clinics and in autopsy rooms These various efforts are being coordinated in such fashion as to furnish full warrant for the statement made by some one whose name is lost to memory that *everything on the earth in the sky above and in the waters under the earth is being searched for its relationship to cancer*

There is every reason for thinking that this search will be fruitful Support for this hope lies in the record of accomplishments not only in the clinics and in the laboratories but also in many other fields cognate to cancer though not ordinarily associated with it in our minds For example industrial management has become keenly alive to the perhaps ominous relationships between cancer and the manufacture of aniline dyes petroleum products illuminating gas coke mineral or lubricating oils textile products of various sorts the extraction of radium ores mining in general with special reference to cobalt and arsenic and all sorts of dust hazards incident to industry in general In turn social agencies have found themselves necessarily confronted with the cancer problem and the legal profession in its relationship to compensation commissions has had its interest curiosity and benevolent spirit of cooperation aroused Thus we secure a view of the ferment of discovery as it works in the peripheral regions of the cancer field

More closely related efforts center in the activities of the physicists biophysicists chemists and physical chemists Through their research activities have come the improvements in x ray and radium therapy that have yielded such brilliant results in the study alleviation and cure of cancer The science of heredity also has furnished tools in the form of genetic principles that are of great value in the study of malignant disease

When we step *in medias res* and get down to the solid business of inspecting the accomplishments wrought not at the periphery of the cancer problem and not in the realms of the border line sciences but directly in the field of cancer itself we encounter a pageant of progress that is truly heart warming And it has all happened in so

short a space of time! The man who first opened the door to modern cancer research, Leo Loeb for years Director of Research in The Barnard Free Skin and Cancer Hospital is still actively at work in St. Louis. His demonstration of the transplantability of cancer cells was followed in rapid succession by the discovery of Ishikawa and Yamagiwa who showed that we may produce cancer at will in laboratory animals with high fraction tars. Then came the epochal studies by Kennaway and his group of co-workers in London of the chemical carcinogens and their relation to products manufactured by the human body itself such as the ovarian hormones bile and the sterols. This was followed by Licassaigne's brilliant work on the relationship between the ovarian hormones and cancer of the breast in female and male mice. Huggins later and very recently started his fruitful work on the interrelated phenomena of testicular and ovarian hormone activity in carcinoma of the prostate. Countless other bricks have been placed in the mortar of cancer research setting up a structure that to any reasonably knowing and optimistic thinker may be roofed to completion in his own lifetime. The detailing of these contributions has no place in such a preface as this.

But that is not all. In these constructive labors toward the end of discovering cause or causes the clinicians in every field and specialty of medicine have added their efforts. Studies of cancer of the cervix lung pancreas stomach tongue breast larynx skin and indeed of every organ and tissue of the body have led to improvements in therapeutic technic and to a more rational concept of the initiation development and course of malignant disease. Where we have failed in a hoped for cure we have often succeeded in furnishing a beneficent alleviation.

And while all this has been going on there has developed an infectious enthusiasm along the line of education teaching physicians the whys and wherefores of cancer and teaching laymen what they should know in order to protect themselves. Tumor clinics in general hospitals and in special cancer hospitals the Federal Government's and numerous State Governments activities in the cancer field special journals devoted to publishing cancer studies medical society meetings devoted to cancer and various other practical agencies have been expanding the professional grasp and knowledge of cancer at the same time that they have been fostering the conservation of life limb and comfort of the afflicted. The American Society for the Control of Cancer has broadened the field of educational effort through its various State branches its Woman's Field Army its monthly magazine of practical and helpful information and through its sponsorship of numerous and widely scattered lectures to lay audiences by qualified experts. Likewise brochures leaflets and widespread advertisements by insurance companies furnish the layman protective information.

So all in all if human spirit and flesh wearied by the search for ultimate cause or specific cure falters in thought before the ore of cancer and hearkens in temporary doubt to the biblical proverb —

Hope deferred maketh the heart sick there is for consolation Shelly's vision of —

Through the sunset of hope
Like the shape of a dream
What paradise islands of glory gleam!

FACTORS IN CANCER PRODUCTION

E V COWDRY PH D *

THAT a great many agents can under certain conditions generate cancer is well known. Were it not for the fact that these conditions occur so infrequently, cancers would sprout almost everywhere in our bodies. The agents are called carcinogens. Two groups can be recognized: those that come from without, and those that are formed within the body.

EXTERNAL CARCINOGENS

Sunlight is the most universal of external carcinogens, but its power of producing cancer is relatively feeble, so that a long exposure through many years is ordinarily required. Nevertheless, sunlight is probably rather more productive of skin cancer than is generally realized, because records are seldom kept of the beginning lesions which are removed by the thousand. If these were allowed to develop unchecked and early cancers of the skin were not easily visible and on the whole promptly treated, the actual operation of sunlight as a carcinogen would be more apparent.

Much depends of course upon the susceptibility of the skin and the degree of exposure. Susceptibility varies. The skin of patients with *xeroderma pigmentosum* (fortunately a rare disease) is so sensitive that the malignant transformation occurs in a few years' time and cannot be evaded. The skin of blondes is more susceptible than that of brunettes. There is some truth in the statement that a blond farmer who heedlessly exposes himself to the sun all his life will acquire skin cancer if he passes the age of 65 years.

The U. S. Public Health Service has found that skin cancer is most prevalent in the state of Texas, where many citizens take pride in their virile, sun-baked appearance. The habit of sun-tanning on sea beaches for a few weeks at long intervals is probably not dangerous except for those whose skin is abnormally sensitive. Yet some dermatologists report an apparent increase in the incidence of skin cancer which they are inclined to attribute to this custom, though convincing statistics are lacking.

It is interesting to speculate on the susceptibility to solar rays of male castrates, of whom the number is greater than most people think. On exposure to the sun, their skin burns, but it has lost the ability to tan, unless testosterone is administered; then it does tan even months after cessation of exposure, as has been fully described by Hamilton.

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Whether this inability to tan denotes susceptibility is not known but it may be the case since the melanin developed in tanning may be more or less protective

Which wavelengths of light emitted by the sun are most responsible for cancer of the skin in man remains to be determined but it is assumed that ultraviolet light leads in this respect since skin cancers in animals can be produced by repeated exposure to it. Though little if any ultraviolet light gets through ordinary window glass some of us know of men who have worked in much the same position for 30 years or more with light coming through a window pane chiefly directed on one side of the face. When the preliminary warning lesions appear it is usually on this exposed side.

Atmospheric dust is often listed as possibly carcinogenic but ideas on it are rather nebulous because it is composed of so many materials and is so variable. That soot constantly encountered can produce cancer is illustrated by the scrotal cancer of chimney sweeps. Experiments in this hospital by Dr M. G. Seelig show that pulmonary cancer in mice can result from inhaled soot. A few years ago atmospheric pollution in some of our large cities became so obnoxious that Shear and others of the U. S. Public Health Service systematically collected dust at about the street level in selected centers and tested its carcinogenicity by the injection of mice. It was found capable of producing cancer especially when collected in certain areas the names of which were not published. It is unwise however to attribute cancer of the lungs to the breathing of ordinary street dust in moderate quantities but dust from chrome, antimony, arsenic and radioactive ores in mines is dangerous.

X rays and radium are assuredly carcinogenic though this fact was not suspected at first. The interval between the last exposure and the appearance of cancer of the skin ranges from about 1 to 11 years. Since these rays are so penetrating the deeper tissues may be injured especially those of the blood forming organs with resultant leukemia. The risk is so great that officers of the U. S. Public Health Service have recently inspected a large number of hospitals to make sure that those using x ray and radioactive materials are adequately protected.

Coal tar products are the most prolific source of carcinogens of extracorporeal origin. The tars themselves are mixtures of numerous hydrocarbons in diverse proportions. The interval between the last exposure and malignant transformation of the skin may be as long as 20 or 30 years. Both tar and ultraviolet light are routinely used with impunity in the treatment of psoriasis and other cutaneous disorders.

Two found California petroleum oil to be noncarcinogenic but refined products made from it were carcinogenic. According to some experts the very powerful new methods of cracking petroleum to

produce high octane gasoline for aviation are more likely than the older ones to generate polycyclic hydrocarbons in the residue oils. These oils are going on the market in enormous quantities and for many purposes. A public health hazard in the cancer field may thus be created for individuals most exposed to them particularly when the oils are vaporized by heat in places where the ventilation is inadequate.

Aniline dyes can bring about cancer of the bladder. These like other excreted chemicals are probably present in the urine leaving the kidneys in far greater concentration than in the glomerular filtrate or in any body tissues and because the bladder serves as a reservoir time is given for action on the lining epithelium. Yet these cancers not infrequently only make their presence felt years after the patient has ceased to work in the dye industry. Latent periods range from 1 to say 17 years. An average of 8 years has been reported.

Burns are of interest because in a few cases they are followed by skin cancer. The interval as given by Heuper is difficult to interpret but may be significant. For chronic burns it is listed at 6 to 41 years with an average of 22 years and for acute burns 1 month to 2 years with an average of 4 months.

Mechanical trauma can also lead to cancer even when it is single as described elsewhere in this volume by Leighton. The tissues most susceptible are the breast and the testicle but dermis and periosteum can respond similarly. In proportion however to the frequency of trauma cancer attributable thereto is extraordinarily rare.

This brief review of a few carcinogens which strike at the body from without supplies data very difficult to interpret. It is not possible to point to any property which these carcinogens possess in common as likely to transform normal cells into malignant ones. In the case of some of them there is reason to think that extent and duration of exposure are important factors. However the rise in temperature in an acute burn and the crushing in a blow on the skin for example are influences of short duration and not necessarily operative over a large area. Individual tissue susceptibility can be demonstrated only in some instances such as that of the skin to solar rays. The fact that cancer in identical twins is usually similar symmetrical and simultaneous coupled with the frequency of gastric cancer and breast cancer in certain families points to an hereditary susceptibility but again in most cases this factor is elusive or absent. Impressive is the great range in length of the interval sometimes existing between the cessation of action of carcinogen and the appearance of cancer also the fact that though many are exposed (aniline dye workers and others) only a few acquire cancer. Recognition of the possibility that other carcinogens in addition to those observed may in some cases operate cannot be evaded.

PRECANCEROUS LESIONS

We speak rather glibly of cancer being produced by carcinogens but there are numerous so called precancerous lesions for which the carcinogens if any are wholly unknown. Thus lupus vulgaris (skin tuberculosis) of 4 to 55 years duration (average 30 years) can become malignant. Syphilitic leukoplakia of the tongue is said to go over into cancer in 30 per cent of the observed cases. But the idea of accepting the tubercle bacillus and the spirochete as carcinogens is not appealing. Regenerative hypertrophic lesions of the liver and endocrines produced by a wide variety of conditions that we do not ordinarily visualize as carcinogenic can also be the seats of malignant changes. The same holds for pigmented moles of the junction type, chronic catarrhal inflammatory lesions of the cervix, polypoid adenomas of the colon and chronic cystic mastitis.

As applied to such lesions the term precancerous is apparently unjustified because many of each type indeed the majority are not forerunners of cancer. Here where definite carcinogens are not identifiable cancer only occasionally develops as it does when the tissues are known to be exposed to easily recognizable carcinogens of external origin whose action can for some patients even be dated.

The question has often been asked whether lesions of these categories have properties in common which render them liable to become cancerous. A rather obvious attribute of all of them is that they are hyperplastic in the sense that they are made up of more cells than the tissues of origin. But this need not be interpreted as always due to an increase in the frequency of mitosis. It could follow from the cells living longer that is from a diminished cellular death rate without change in mitotic frequency. However this may be it is generally admitted that the malignant transformation occurs not throughout the lesion but in one or more very small groups of cells and because these cannot be identified in advance and continuously observed it cannot be ascertained whether they were multiplying at the rate usual for the tissue before the lesion developed or more rapidly or more slowly. On the whole pathologists have shown little imagination and ingenuity in the bringing to bear of new techniques of examination on precancerous lesions as they occur in patients. It should at least be feasible to examine those easily biopsied for fluorescent carcinogens and to determine the intake of radio elements. After assembling the apparatus one could quickly make both tests.

Turning to the lesions of a given type say syphilitic leukoplakia one wonders why the minority become cancerous while the majority do not. Is it because in each type there are really lesions of two sorts which we cannot as yet distinguish one truly precancerous and the other not or are they of a single kind and a carcinogen happens to act on only a few of them while most escape or are they of the same kind similarly exposed to a carcinogen the action of which is

for some obscure reason usually inhibited³ Certainly there are many possible factors At present we see through a glass darkly Yet these and other precancerous lesions as well as the carcinogens of external origin are clearly before us for analysis

INTERNAL CARCINOGENS

The margin fades when one considers the possible role of internal carcinogens produced and hidden in the depth of the tissues whose action cannot be dated A large group of steroid compounds is under suspicion in this connection Cholesterol is not implicated It is mentioned only as a familiar example of the sterols which are higher alcohols of solid consistency Many hormones are ketones of the sterols (corticosterone testosterone progesterone androsterone etc) Some estrogens are sterones and these from experiments on animals are known to be capable of initiating cancer in susceptible tissues More over studies in Barnard Hospital by Paletta and Max on mice have demonstrated that the development of squamous cell carcinomas consequent upon applications to the skin of methylcholanthrene is greatly increased by injections of estradiol benzoate a synthetic estrogen Though we cannot as yet point to a definite cancer in human beings and positively assert that it has been produced by estrogen the handwriting is plain upon the wall that steroid estrogens should be administered with the greatest care and moderation when there is reason to suspect that any tissues are in a particularly susceptible state or when there is the possibility of existing precancerous lesions such as chronic cystic mastitis

In patients when cancers occur in the duodenum they are most frequently observed near the ampulla of Vater where bile enters from the liver This may be a coincidence but steroid compounds of considerable variety are poured into the duodenum at this point Methyl cholanthrene is not only the most potent carcinogen but it is also chemically related to the bile acids It may be that human bile contains similar carcinogens which act on the duodenal and other tissues of the lower alimentary tract when these tissues are unduly susceptible To assume that internal carcinogens are limited to steroid compounds would be blind complacency

ANIMAL EXPERIMENTATION

Thus far this account has been mainly limited to cancer in man because it is not always good practice to assume that what happens in animals also takes place in human beings Obviously however well controlled animal experimentation does expand our concept of cancer as a biological phenomenon and may supply valuable clues in the investigation of the etiology of human cancer

Virus Theory—Some instances of cancer production in animals by viruses can be cited The best known cancer virus is the Rous sarcoma

virus of chickens. After it the renal carcinoma virus of frogs was discovered by Lucke and a few years later the skin carcinoma virus of cottontail rabbits by Schöpe. But any balanced judgment must take into consideration the almost insignificant number of cancer viruses compared with the hundreds of carcinogens. While it would be foolish to deny the possibility that man like the lower animals may occasionally be afflicted with cancer viruses, there is little reason seriously to entertain the view that viruses may be the etiologic agents of many kinds of human malignant tumors.

Yet proponents of the virus theory seem to be increasing. They have a belief in things undemonstrable at least not yet shown in the form of a series of inapparent or latent viruses which only in exceptional cases are supposed to reveal their presence by cancer production. This is a considerable stretch of the imagination for though latent viruses do occur in animals as well as in human beings they usually operate in other ways than in carcinogenesis. Failure regularly to demonstrate the existence of viruses in human cancers is waved aside by assuming that the hypothetical viruses resemble known viruses that are strongly species and even strain specific and differ from many others that can operate in a wide selection of animals. This tendency to picture these viruses as preying only on human beings so that evidence as to their presence is not to be expected by inoculating experimental animals with extracts of human cancers is supplemented by an inclination to dismiss the absence of evidence that human cancer like most virus diseases is infectious in nature because of the circumstance that most cancers are internal and skin covered so that the opportunities for spread are not great. The passive extension of viable cancer cells on the surgeon's instruments to other parts of the patient is not significant in this connection because it is transplantation not infection and whole cancer cells are not a virus. Similarly the occasional production of cancer in animals by injection of extracts of human cancers and of livers cannot be taken as indicative of a virus because the agent involved must be assumed to be simply a carcinogen until it is found to have the properties of a virus.

Influence of Heredity.—The habit of carcinogens to misfire to fail in the production of cancer noted in human beings to some extent can be analyzed in animals. That some strains of mice of one and the same species are hereditarily more resistant than others to equal doses of the same carcinogen has been proved. It is however too soon to say whether all cells share in this inherited resistance or lack of resistance (susceptibility). Recent studies give better perspective of the immediacy of hereditary influences. Some traits considered germinal in other words determined by union of egg and sperm on fertilization are really environmental. Particularly important is the influence of the uterine environment on the developing embryo. It has been discovered in Dr. Clarence Little's laboratory that if fer-

utilized ova of a strain of mice having sacra made up of 5 vertebrae are transplanted to the uteri of mice of another strain having 6 vertebrae in their sacra they will develop into mice possessed of sacra composed of 5 vertebrae

Coming closer to cancer Bittner finds that when newborn mice of a strain characterized by a high incidence of spontaneous mammary cancers are nursed from the beginning on mice of a low incidence strain they acquire mammary cancers in the low frequency of their foster mothers. The reverse also holds: mice of low frequency nursed on those of high frequency develop the high frequency of mammary cancer. The substance in mouse milk responsible for high frequency has been isolated and purified, and its influence proved up to the hilt. It is called the *milk influence*. To demonstrate the existence or absence of such a substance which is not a steroid but a protein of large molecular size in human milk requires the kind of experimentation that cannot be performed. But interpretations of the possible role of heredity in human cancer must take into consideration a host of factors that may influence the offspring which are not germinal but environmental.

Carcinogen Activity—Our concept of the immediacy of the action of carcinogen is also expanding. Many more carcinogens are known to be capable of producing cancer in animals than in human beings. One hundred and fifty or more polycyclic hydrocarbons are effective. Even applications to the skin of hydrochloric acid and potassium hydroxide and subcutaneous injections of such seemingly benign materials as lard and olive oil are in rare cases followed by cancer. The course of events leading to cancer may be long or short with a few or many chances of interruption before the malignant transformation takes place. The original carcinogen usually disappears entirely from the picture. There is reason to suppose, however, that the ultimate kick delivered to the susceptible cells is in all cases similar for the malignant change in whatever tissue it occurs has certain common properties. It frees the cells from the usual regulation of mitosis and this freedom is ingrained in their constitution and passed on from cell to cell.

It is too early to conclude as a committee of experts appointed by Surgeon General Parran has done that "Malignancy is a universal cell potentiality" in that any cell has inherent in its make up the potentiality for unlimited or uncontrolled growth. This statement may mean that all cells without exception can undergo the malignant change if the carcinogenic influence is sufficiently strong and sustained and the necessary enabling conditions are operative. Perhaps the committee had in mind only cells in the stages of their individual lives capable of division to begin with or which could be made capable by the carcinogen. Most cells are able to divide at some period in their life but we are not sure that this is a universal cell potentiality. For in

stance it is questionable whether spermatids produced by the division of secondary spermatocytes can multiply. Other examples of probable inability of cells to divide at any time during their lives can be cited. In this problem many imponderables somehow must be weighed. It could be argued that the cells which do not ordinarily divide at any time—a fact possibly correlated with high differentiation dating from the mitosis that gave them birth—do not in themselves possess the potentiality of malignancy but can nevertheless be so modified (de-differentiated) by the carcinogen that the ability to divide possessed by their less differentiated ancestors is restored to them. This may be the view of the committee but even so the phrase "universal cell potentiality" is difficult to accept. It would be well to substitute for it "widely occurring cell potentiality" of malignancy.

That the immediate or many times removed influence of carcinogens on cells capable of becoming malignant is subject to modifying factors is suspected in human beings. In other words it does not seem likely that the great variability noted in cancer production by a given carcinogen can be wholly explained as due to differences in amount or duration of carcinogenic quality or in susceptibility or amount of tissue exposed. But naturally occurring accelerating and inhibiting factors are in man very intangible. By purposeful experiments on animals this concept of modifying factors is somewhat extended because doses of carcinogen can be standardized and the influence of possible factors investigated one by one. Most of the work has been done on mice treated with tar or with chemically known carcinogens. A few of the legion of modifying factors reported are

Accelerators

Beta rad at on
Burns
Vitamin A B C D and E rich diets
High fat diet
Feeding fresh liver and dried thyroid
Sympathectomy
Dinitroresol
Estrogen

Inhibitors

Barium salts
Subcutaneous injections of adrenalin
Vitamin A B and E rich diets
Diets deficient only in calories
Diets deficient in cystine
Hypophysectomy
Mustard gas
Testosterone

The accelerators are said to give a better yield of cancers and the inhibitors to reduce the number of cancers, to delay their appearance or both, seldom if ever entirely to prevent the malignant transformation.

Though some of the reports are based on thorough investigation, others are open to criticism for several reasons that need not be specified. It is safe to conclude, however, that accelerating and inhibiting factors can be found. Therein lies a grain of hope for it means that efforts to aid tissues known to be unusually susceptible and to have been heavily exposed to some carcinogen may not forever be futile. It is also evident from a careful study of many such reports that the

search for modifying factors has been rather a hit and miss undertaking usually by individual workers who are trying to follow hunches or fancied clues *Organized research* on a large scale is long over due This clearly would have two objectives first to discover inhibiting factors feasible of application and second by amassing comprehensive data on inhibitors and accelerators to attain reliable evidence on the nature of the process or processes subject to their influence that is of the central means of carcinogenesis

Vulnerability of Cells—A different problem that it is not our purpose here to discuss is the vulnerability of cells which have become cancerous The influences that may conceivably result in retarding their multiplication and even in killing them may be quite different from those which operating on cells not yet malignant inhibit or accelerate the development of cancer for cancer cells are very different from noncancerous ones Moreover there are notable differences in speed with which cancer grows in individual cases occasionally growth is arrested and the cancers become latent and rare reports of spontaneous regression and complete disappearance of cancers cannot be altogether discounted as fictional Consequently cancerous growth is modifiable and we may look forward to the day when the nature of these naturally occurring influences is discovered and means are devised whereby cancer can be adequately treated But progress will be conditioned by systematic investigation of this vulnerability We must cease to diddle and bring to bear the energy determination and the ignoring of expense which have proved effective in researches on war problems

SUMMARY

Many external carcinogens acting on the body from without are now recognizable It is our task to reduce exposure to the point where the hazard is eliminated and to be on the lookout for evidences of unusual susceptibility Carcinogens generated within the body are to the best of our knowledge mostly steroid compounds such as estrogen related to cholesterol but other kinds may operate In the presence of precancerous lesions these internal carcinogens are particularly dangerous In addition to exposure to carcinogen and tissue susceptibility little known factors influence both the course of carcinogenesis and the growth of cancer once it has started It is because of insufficient exposure low degree of tissue susceptibility and inhibiting factors that cancer is not much more prevalent

SINGLE TRAUMA AS AN INCITING FACTOR IN CARCINOMA

W E I EIGHTON MD

We have recently reviewed the role of trauma in initiating cancer with the resultant disclosure that 79 patients seen in the surgical service of The Barnard Free Skin and Cancer Hospital from 1910 to 1930 developed cancer following a single trauma on the surface of the body at a site which could be visualized daily and frequently and appearing in many instances at an age period of life when cancer is unusual.

The purpose of this paper is to confirm anew the validity of these and similar findings by reporting the influence of a single trauma on one select organ of the body. I propose to analyze 13 cases of cancer of the penis seen at the Barnard Free Skin and Cancer Hospital, in every one of which a history of the reception of a single trauma to the penis was present and the growth followed all the postulates laid down by Segond as necessary to establish the causal relationship between trauma and the later development of cancer.

CASE I—In January 1934 a laborer 78 years of age entered the Barnard Free Skin and Cancer Hospital. In July 1933 6 months before he started a blow which bruised the shaft of the penis. The condition did not improve and 4 weeks later he consulted a physician but no treatment was given. In September 1933 he applied to a clinic for a diagnosis and advice but was not satisfied and again was untreated. On admission to our hospital in January we found on the dorsum of the shaft of the penis an ulcerating tumor 5 by 2 cm with hard indurated edges. The lymph nodes in both inguinal regions were enlarged and hard. There was also present a right inguinal hernia. He denied any venereal disease. There was no history of cancer in his family. The authenticity of the trauma was established.

On January 17 1934 a radical operation was performed. This consisted of a total amputation of the penis with transplantation of the urethra into the perineum and bilateral inguinal adenectomy with right herniorrhaphy. He made good recovery. The pathological examination was returned as squamous cell carcinoma, grade 2 with metastases.

CASE II—A miner aged 50 years while riding horseback was thrown onto the pommel of the saddle. The penis was caught between the pommel and the shooter and was badly mashed but healed in a few weeks. One year later he was lured again in the same way and since then has had a running sore. The penis was partially amputated at Grand Rapids where diagnosis of cancer was made. In April 1909 four years after the original injury. Examination in November 1909 showed his penis to be entirely gone and the scrotum was involved in a hard mass. Bilateral malignant involvement of the femoral nodes was present.

CASE III—A farmer aged 46 years injured his penis on the horn of a saddle about 2 years before we saw him. A girl with devil ped on the inner side of the prepuce and circumcision and a right inguinal dissection were performed.

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February 19 at Kansas City There was a recurrence of the trouble in the right inguinal region and at operation 6 months later a pathological diagnosis of cancer was made At this time the penis and scrotum were swollen and edematous The inguinal nodes on the left were enlarged and ulcerating

CASE IV—A farmer aged 49 years while working on the highway was struck with a knotted rope on the glans penis bruising the glans which became black and ulcerated The condition improved for a while under home remedies but 8 months later it began to grow gradually worse Examination on admission showed the whole glans and most of the shaft of the penis to be included in a carcinomatous mass A radical operation was performed The pathological diagnosis was squamous cell carcinoma grade 2 The patient denied venereal disease and the family history was negative for cancer

CASE V—A laborer aged 55 years was circumcised about 15 months ago because of a redundant prepuce The wound failed to heal and a tumor began to grow The lesion eventually involved the entire glans and shaft of the penis A radical operation was performed in August 1933 The pathological report was squamous cell carcinoma grade 3 with metastasis There was no history of venereal disease and the family history was negative for cancer

CASE VI—A watchman aged 50 years was circumcised 3 years ago The wound did not heal and he had recurring ulcers Two months ago the right groin began to swell It was opened 2 weeks ago at the DePaul Hospital and a large amount of pus was evacuated It has been draining ever since At this time there is an ulcer on the inner side of the foreskin 2 by 2 cm with pearly base and piled up edges In the right inguinal region there is a wide area of induration dusky red in color only slightly tender in the center of which is a cauliflower like growth A biopsy from this area was reported squamous cell carcinoma grade 3

CASE VII—A farm laborer aged 52 years while working 2 months ago on a farm with 2 mules threw the hitching rope around a post From the straining of the mules the rope broke and the end struck him on the penis He had some pain and swelling at the time which gradually subsided during the following 2 weeks Then an ulcer and swelling appeared and he went to a physician who made a dorsal slit in the prepuce The lesion has increased rapidly in size with no evidence of healing Examination showed a large cauliflower like mass completely destroying the glans penis The inguinal nodes were palpable on both sides There was no venereal history One sister had died of cancer of the stomach Operation was refused A clinical diagnosis of carcinoma was made by us

CASE VIII—A farm hand aged 58 years about 2 years ago was injured at the base of the penis by the limb of a tree The area became ulcerated and the ulcer grew steadily in size There was some pain but no bleeding Examination showed an ulcer 4 by 5 cm involving the pubic area and extending onto the shaft of the penis There was no induration or piling up of the edges The nodes were palpable in both inguinal regions A radical operation was performed The pathological report was squamous cell carcinoma grade 2

CASE IX—A shoemaker aged 44 years was circumcised 4 years ago for itching but no sore beneath the prepuce The wound did not heal On admission to the hospital the left half of the glans was occupied by a cauliflower flattened lesion 3 by 4 cm in size with an indurated base Radium was employed and later an inguinal dissection was carried out There was no history of venereal disease or a family history of cancer The lesion was a squamous cell carcinoma

CASE X—A painter aged 57 years about 3 months ago while cranking his car crushed his penis. About a month later the lesion began to ulcerate and he consulted two different physicians who applied washes and ointments. Examination revealed an ulcer on the dorsum of the shaft and glans penis. The inguinal nodes were enlarged and hard. A biopsy at this time was reported squamous cell carcinoma grade 2. There was no history of venereal disease. The Kahn test was negative and there was no family history of cancer.

CASE XI—A shipworker aged 46 years received an injury to the glans penis in April 1938. In September 1938 he consulted a physician and a dorsal slit was made because of a redundant prepuce. Ultraviolet radiation did not improve the condition and a biopsy in December 1938 was reported squamous cell carcinoma grade 2. He then applied at our hospital. On examination an ulcerating lesion was found in the right side of the glans penis involving the testis of the corona. No enlarged inguinal nodes were found. Radiation to the penis and an inguinal dissection failed to check the cancer. There was no history of syphilis and the patient was histologically negative. One uncle had carcinoma of the face.

CASE XII—A packer aged 40 years was in a fight 3 years ago with a resultant lacerated foreskin which was followed in 3 weeks by an ulcer. He secured no treatment for 2½ years at which time a circumcision was done. The sore did not heal. A biopsy was reported squamous cell carcinoma. On examination the patient was seen to have an extensive ulcerating process on the glans penis and a red indurated tumor in the right groin. A brother died at the age of 50 years from a carcinoma of the testis.

CASE XIII—A machinist aged 37 years was admitted to the hospital on January 8, 1943 with the history of having sustained a severe bruising injury to the glans penis when he fell in a bathtub 18 months previously. In February 1943 he noticed a red raised area beneath the foreskin on the glans penis. This was diagnosed as a chancre and he was given shots in August. There was a discharge from the urethra at the beginning of urination. A circumcision was done in October 1943. There was no improvement, the wound did not heal and a biopsy at this time revealed cancer. He was treated with x-ray until admission to this clinic. Neither radiation nor radical surgery was of any value as the cancer continued to grow. He admitted a venereal infection in 1933 but denied the presence of syphilis and the Kahn report was negative. His mother and sister had died of cancer. Examination on admission showed a large cauliflower mass on the glans penis with a necrotic surface and a hard indurated base. The pathological diagnosis was squamous cell carcinoma with metastasis.

ETIOLOGY AND INCIDENCE

In 1932 I discussed the commonly ascribed causes in 67 cases of cancer of the penis. Carcinoma of the penis as a rule arises from the epithelium covering the prepuce or glans penis. In rare instances it starts from the mucous membrane of the urethra. The specific cause of the disease as of all carcinoma is unknown. Various factors appear to contribute toward initiating this disease.

A common contributory condition is *phimosis* which is found to be of frequent occurrence in those cases in which careful histories have been taken. It was noted in 13 of our patients. Barney found it present in 85 per cent of those cases in which inquiry was made as to its occurrence and Martin found it in 6 out of 7 cases. Irritation from smegma under the tight prepuce of elderly men is frequently

the starting point of carcinoma. The importance of this condition is emphasized by the fact that among the Jews and the Mohammedan population of India by whom circumcision has been practiced for ages carcinoma of the penis is almost unknown. There were no Jews in the present series. Greensfelder however reported a case occurring in a circumcised Mohammedan among 202 cases collected in India and Pacha of Constantinople in 4 years saw 5 cases of carcinoma of the penis in circumcised Mussulmen.

Syphilis at times seems to be of etiological significance since it is not uncommon to find cancer developing upon the site of a chancre. Martin thinks the ground for this supposition is not tenable although he has seen such a case. Sheild and Green also each saw a case. Barney reports 2 cases and Demarquay in an analysis of 59 cases found a history of syphilis in 10. In 2 of our cases carcinoma developed at the site of a chancre. Seven of the patients gave a history of syphilis 4 of whom had received treatment. A positive Wassermann reaction was obtained in 4 cases. A history of gonorrhea was obtained in 11 cases.

Trauma probably plays the same role in the causation of cancer of the penis as in cancer at other sites. Kronlein reports a case of penile cancer following trauma. In the series of 67 cases reviewed by us in 1932 2 patients developed cancer following a crushing injury and in another case the cancer developed on the scar of an old laceration. Rodman and Whiteford each saw a carcinoma which had developed upon an earlier circumcision and Barney reported 6 such cases. Sixteen of the patients in the series had been circumcised in adult life in 11 of these the wound did not heal and carcinoma developed. Dormanns in a period of 18 months in China received for examination five specimens of cancer of the penis. Three had been removed from young men 24, 26 and 36 years of age respectively. In all instances the skin was markedly inflamed and showed microscopic changes similar to those produced by tar. In seeking an explanation for this it was found that gonorrhea, syphilis and chancre were treated in this locality by the local application of a highly irritating substance the nature of which Dormanns was unable to ascertain.

Contagion or rather *implantation* has been suggested. In 1895 MacFarland searching the literature found 8 cases of contagion from wife to husband. Bernstein reported a case of possible contagion from husband to wife. Bruce saw a patient who developed cancer of the penis one year after his wife died from carcinoma of the uterus. Outland reports a similar case and Cornil reports 2 cases which he thinks confirm the direct contagion of carcinoma. Frank cites the case of a man aged 39 years who developed carcinoma of the penis 5 years after his wife died of carcinoma of the uterus. His case however is similar to Case IX of the present series which would

seem to be purely coincidental. Barney reports a case of auto-implantation on the scrotum due to contact with cancer on the penis.

Origin of the Growth—In 30 of our cases the disease began on the glans penis, and in 13 the first appearance was on the prepuce while a few patients thought that their growths began in the sulcus. Only cases were recorded as beginning on the frenum. Barney noted that in a few instances the growth was limited to the point of origin but in most it had spread so as to involve both glans and prepuce. Our experience was similar. Demarquay and Thomson state that the lesion occurs more frequently on the glans penis while Kaufmann reported 70 of 33 cases observed by him as occurring primarily on the prepuce and only 13 on the glans. One of our cases originated in the urethra at the penoscrotal junction.

Age Incidence—The age at which carcinoma of the penis develops corresponds with that in carcinoma of other organs. Crete reports a carcinoma of the penis in a boy of 2 years. Freyer in a boy of 15 years. Ralph in a young man of 22 years and Fielewicz in a young man of 26 years. While a few cases occur in the 20's the condition is most common between ages 50 and 60. Forty-five of our cases occurred after age 50. The ages of the patients on admission ranged from 30 to 77 years. Seven patients were between 30 and 40, 17 between 40 and 50, 21 between 50 and 60, 14 between 60 and 70 and 2 between 70 and 80.

Racial Incidence—Fifty-four of the patients were born in America, 8 in Germany and one each in Ireland, Holland and Switzerland. In 7 cases the nationality was not recorded. Sixty-two patients were white and 5 colored.

No race is exempt from this affliction unless it be the Jews. Contrary to the experience of Rodman and Barney, who never saw a carcinoma of the penis in a Negro, Thomas and McCoy each report a case occurring in a Negro. Four out of 5 patients treated by Shivers at his clinic at Atlantic City were colored and Howze reported 6 Negroes in 17 cases. There are 5 colored patients in the present series.

Application of These Facts to the Cases Reported Here—Bearing in mind this review of the etiology of carcinoma of the penis let us consider the causes of cancer of the penis in the 13 cases which form the basis of this paper.

In Case I there is no evidence of any possible cause of cancer other than the single injury which was severe enough to bruise the skin on the shaft of the penis, a most unusual site for a carcinomatous growth. In order to establish a relationship of trauma and malignancy in this case let us consider the postulates of Segond:

- 1 The authenticity of the trauma was established
- 2 The trauma was severe enough to contuse the shaft of the penis
- 3 As to the integrity of the part there is no evidence of the pres

ence of a sore prior to the injury. Had any lesion been present, it is not likely it would have gone unobserved since no part of the body with the exception of the hand is more frequently observed or inspected than is the penis.

- 4 The tumor appeared at the exact location of the injury.
- 5 A tumor was present 6 months later and from the reception of his injury to its removal the bridging symptoms were continuous and progressive.
- 6 The diagnosis of squamous cell carcinoma with metastasis was established after operation by our pathologist.

From the history and evidence submitted it would seem reasonable to consider the trauma as the etiologic factor in this case.

All of the remaining case histories emphasize trauma described either as a contusion, a laceration or an incised wound such as circumcision. One is impressed with the failure of the patients to notice prior to this trauma any of the usual forms of chronic irritation or the presence of sores or tumors in an organ which is inspected so frequently. The trouble seems to begin with the reception of trauma and the bridging symptoms from trauma to tumor are continuous and progressive.

The age incidence in these patients is striking. Fifty three per cent were under 50 years of age whereas in the remaining 125 cases of our series of cancer of penis with no history of trauma only 20 per cent of the patients were under 50 years of age. Lest there be any suspicion that the penis is an organ especially susceptible to cancer development after injury, I can cite numerous case reports from the literature of carcinoma following a mild trauma to various other regions of the surface of the body in early life.

Brown and Brown in 1928 reported an epithelioma in a boy of 15 following an injury to his leg.

Rixford in November 1935 recorded the case of a boy of 17 who following an injury to his breast, developed a malignant tumor and later a metastatic carcinoma to the axilla.

Marques in a review of 53 cutaneous cancers following trauma observed that 15 of the patients were under 30 years of age and 5 of these were under 17 years of age. He concludes that the problem of the relationship between trauma and malignancy has actually passed from the domain of hypothesis into reality.

The youth of some of the above patients is striking in the light of the findings of Hall and Bagby who recorded only 5 cases of spontaneous cancer in patients under 20 years of age in reviewing 70 000 case histories from the Barnard Free Skin and Cancer Hospital.

The appearance of a carcinoma following injury anywhere on the superficial surface of the body at an age when carcinoma rarely occurs spontaneously suggests that the trauma or injury is the exciting cause.

Ewing in his paper in the *Bulletin of the New York Academy of Medicine* in 1935 referred to the *bridging symptoms* as follows

The so called *bridging symptoms* between the injury and the appearance of the tumor are of interest and occasionally of importance. When the evidence shows that a wound of apparently normal tissue never healed that pain swelling and discharge persisted for weeks and until the definite appearance of a malignant process, then one must accept a presumption in favor of the traumatic origin and rely upon other features if the traumatic theory is to be rejected.

Cancerigenic Agents—The variety of external influences now known to act as *exciting agents* in the production of cancer is great and covers almost every class of natural force. Some act directly others indirectly. Among the causes of cancer mentioned by Ewing are the following: (1) mechanical trauma especially when repeated (2) physical agents roentgen ray radium and sunlight (3) chemicals in organic and organic such as arsenic chloride of zinc coal tar products aniline dibenzanthracene phenanthrene Sudan III and other dyestuffs (4) organic cell products hormones folliculin estrin decomposition derivatives of the bile acid (Cook) (5) bacteria especially the tubercle bacillus *Bacillus caviae* of Lacassagne the virus of infectious epitheliosis (Shope) (6) animal parasites the *Spiroptera neoplastica* (Fibiger) *Iaenia crassicollis* (Borrell) *distomasis*. All the exciting causes of cancer were reviewed by Maisin (Madrid Congress 1933).

Ewing further states: it thus appears that the scope of cancerigenic agents is coextensive and nearly identical with the excitants of inflammations. This fact compels the conclusion that both processes inflammation and neoplasia are the expression of universal cell properties and are correlative. Inflammatory agents produce degeneration necrosis exudation growth of new tissue regeneration and are usually self limited but sometimes run into neoplasia. Cancerigenic agents also produce some degeneration often exudation but mainly overgrowth of tissue with various grades of anaplasia and they are usually but not always progressive. The manifestations of inflammation vary greatly but within certain limits. Inflammatory neoplasia passes by insensible gradations into neoplastic.

The histological structure of a cancer but not its actual cause is known. The one characteristic of tumors which can be recognized generally is the cell autonomy or independent growth which is unlimited and uncontrolled. Normal cells are under control. What causes the mass of cells in a tumor formation to run riot? One of the most striking factors developed in experimental research is the action of coal tar products in the formation of tumors. Is the tumor the result of the coal tar or some other unknown quantity? Yamagawa and Ichikawa made from 55 to 360 daily applications before they succeeded in producing 8 tumors. Yet the fact that cancer can be pro-

duced by such substances is accepted although the exact mode of action of these highly cancerigenic coal tar products has not been traced. In all these experiments the positive fact of injury arises not once but repeatedly. If it varies in such wide degree why would it not be possible for a single injury to produce the same result? When I raised this query in 1939 I was unaware that this question had been answered by Findlay who in 1925 had produced a cancer in a mouse by a single application of tar and that in 1939 Mider and Morton were able to produce both benign and malignant tumors in the skin of mice by a single application of methylcholanthrene in 57 brown mice.

The latest contribution on this subject is that of Cramer and Stowell who record that a single application of methylcholanthrene will produce a massive hyperplasia within 4 weeks in some mice while repeated applications for 2 months or more will fail to do so. They therefore distinguish two distinct groups in the same strain: (1) a susceptible group in which a single application will produce a massive hyperplasia which may or may not lead to cancer; (2) a resistant group in which the skin suffering the initial injury from a single injury merely regenerates without developing subsequently a massive hyperplasia. From their studies of the effects of a single exposure of the skin of mice to methylcholanthrene Cramer and Stowell conclude that the conditions required to produce this response are a considerable total dose of a powerful carcinogen applied to a large area of skin. Under such conditions the carcinogen injures the epithelial elements of the skin which respond by regeneration. This regenerated epithelium is altered in its reaction to subsequent applications of the carcinogen, having become more resistant to its toxic effects. In a fraction of the animals the regenerated epithelium proceeds without further application of the carcinogen to a massive epithelial hyperplasia culminating in the localized development of a skin carcinoma. The reaction of the skin to the carcinogen in this group of animals, the susceptible group, contrasts strongly with that of the resistant group. In resistant animals the carcinogen also produces an injury of the skin followed by regeneration. But in this group the regenerated epithelium does not proceed automatically to a massive hyperplasia; it even fails to do so when subjected to an unremitting application of the carcinogen extending over several weeks.

There are many references in the literature to carcinoma developing on the site of a single injury and while they have been accepted by some they have been repudiated by others.

Since it is now proved that a single chemical trauma may produce cancer in a susceptible animal, may we not assume with acceptable logic that a single physical trauma (bruise, burn or cut) may bring about the same effect in a susceptible human?

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ADEQUATE X RAY AND RADIUM DOSAGE

EDWIN C. ERNST, M.D., F.A.C.P.*

THE goal towards which all of us who treat cancer are striving is a type of therapeutic management that will be uniformly effective.

During the past several decades we have witnessed a succession of new radiation developments in the field of electrical engineering and high voltage x ray machines. The intensity and voltage of these rays have been increased in order to facilitate penetration of the rays to a depth unheard of in the past and this with a minimum absorption or injury to the superimposed normal structures overlying the tumor bearing area. Likewise the universal adoption of more accurate methods of measuring these powerful roentgen energies has been epoch making.

It should be emphasized, however, that radiation therapy is not solely dependent upon elaborate x ray machines, dosage measuring instruments or large quantities of radium, but it is equally contingent upon the judgment, experience and that indefinable attribute called radiation sense of the radiotherapist, be he surgeon, gynecologist, pathologist or radiologist.

On the other hand, if we had been deprived of these new methods of measuring accurately the quantity (amount) and the quality (strength) of these more powerful rays, the present therapeutic effectiveness of radiation in the treatment of malignant neoplasms could not have been so satisfactorily utilized. Comparative statistical studies and the accurate evaluations of known clinical radiation responses would likewise have remained in the realm of empirical speculations.

BIOLOGICAL RADIATION EFFECTS

It has not been fully appreciated or realized that the therapeutic rays of x ray and radium possess powers of producing directly or indirectly varying degrees of physical, chemical and biological changes.

The average physician and surgeon occasionally inadvertently refers a patient to the radiation department for a few shots of x ray without realizing that a much longer and more complicated method of therapy is indicated. In the meantime the patient has built up false hopes for an immediate recovery after a few visits and then when the treatments are prolonged becomes increasingly noncooperative. Each specialist in his chosen field does not always understand the problems of the other.

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The same type of cancer in various individuals may be found to react differently even though the same form of radiation has been applied. Again the rays from x ray or radium may inhibit or destroy in a dual capacity the living tissues depending upon the time interval and manner in which the x ray dose is applied. The reactions which tissues show to irradiation and the degree of cell sensitivity to like doses of x ray may also vary.

For example lymphoid tissue and vascular endothelial cells are extremely sensitive to smaller doses of roentgen or radium intensities. Perhaps few of us have given thought to the possibility of chemical reactions in simple or complex organic or inorganic compounds that even elementary substances may result from applied radiations. Ionization may take place transforming nonconducting air into air that is electrically conductive. Variable absorption of the cells of different penetrating forms of radiation energy further complicate the problem. Different tissues may react differently to similar doses of radiation. Again, in the active stage of division some cells are more easily affected by irradiation than during the arrested stage.

Early research studies of Bergonie and Tribondeau¹ revealed that when equal doses of x rays are applied to the testicle of the rat the more rapidly growing cells show the greater effects. Clinical observation indicated that all forms of radiation affected neoplastic structures although the surrounding normal tissues showed little or no change.

The latent periods of different cell structures also vary with different tissues. In some the time interval elapsing between irradiations and the resulting physical reactions is relatively short even though the type, quantity and method of administering such radiations are identical. Usually large amounts of irradiation applied in a short time may prove less effective than the smaller divided doses of equal intensity when applied over a longer period of time.

True with the advent of more accurate modern means of measuring the x ray dose our problems in cancer therapy have been somewhat simplified. However although a standard unit of x ray dosage has been made available and is today universally employed the practical clinical question of adequate dosage still remains a complicated problem. Many factors in the biological reactions to x ray radiation will require continued laborious work from a clinical research standpoint.

It should be emphasized that any conclusions reached and presented could not have been made possible without the full cooperation of the various specialties. The surgical, pathological, medical, research and dermatological departments labored unselfishly throughout all these years in the interest of clinical cancer problems.

ROENTGEN UNIT RESEARCH DEVELOPMENTS

During the early twenties after the first World War research activities were suddenly stimulated in the undeveloped fields of etc.

ology and treatment of cancer As a result the demands upon the radiation phases of cancer research and treatment became more exacting The directors of Barnard Free Skin and Cancer Hospital realized the probable significance of radiation therapy in the fields of future research developments and no opportunity was lost in expanding its radiation department facilities

Early in 1923 our hospital was fortunate in receiving a generous donation for the specific purpose of purchasing a modern high voltage 700 kv peak x ray therapy transformer which was the largest available machine at that time However it was soon discovered that the x ray beam intensities thus made available were far greater and more effective than any of us had anticipated

For example in our initial research studies in cancer we observed that when irradiating the entire body of smaller animals there was need for more exacting dosage standards In the past when smaller areas of the human body received the usual routine x ray treatments differences in the clinical effects due to slight variations in the accuracy of the dose appeared less significant Failures or successes of the effects upon animals were contingent upon absolute constancy and accuracy of the x radiation Future research developments therefore were dependent upon our ability to harness more exactly these powerful energies Additional safeguards had to be developed towards obtaining greater uniformity of the available unlimited effects of the roentgen ray Even though duplications of our experimental x ray doses were made on successive days under apparently exact conditions of constant input voltage the output of the x ray machine lacked satisfactory radiation uniformity

We were partially successful in solving some of these problems and in 1925 reported our findings of improved methods of stabilizing the output together with recommendations for a standardized unit system of roentgen energy before the Radiological Society of North America We prefaced our remarks in this contribution as follows

The intensity or effective wave length output of our present high tension x ray transformers and x ray tubes does not appear to be either scientifically or practically uniform and constant at least not sufficiently accurate to permit the desired exact duplication of dosages even though the determinations are made under the most favorable conditions of constant voltage and tube current A review of the many careful recent researches of the physicists studying the problems more or less substantiate our practical experiences and observation in the administration of x ray dosages in our daily clinical routine treatment and biological researches in the Barnard Free Skin and Cancer Hospital²

Experimentally³ and clinically we could now duplicate our doses with reasonable accuracy provided we employed one and the same x ray machine However since similar types of apparatus of one manufacturer might develop different roentgen outputs we urged the formation of a Standardization and Investigating Committee for

the express purpose of stimulating efforts towards the development of a national standard unit of x ray intensity. It was early realized that a practical international unit should be devised for expressing x ray and radium dosage by a symbol or letter—analogous to the present v for volts which is universally employed to designate a known quantity of electrical current.

At this period of roentgen therapeutic development at least five different units had been described. Among them was Professor Duane's electrostatic unit designated by the small letter e . A committee of physicists and radiotherapists was subsequently appointed by the Radiological Society of North America⁴ and the following year this committee met at the Bureau of Standards office in Washington and established the present known preliminary basic criteria for such a unit⁵.

A national physical standard laboratory had to be selected for and in developing and preserving such a unit of measurement. Dr. George K. Burgess, Director of the U. S. Bureau of Standards, agreed to accept these responsibilities provided we could persuade the Congress of the United States to appropriate funds for creating a new x ray department in the U. S. Bureau of Standards. Subsequently the efforts of our committee were rewarded and Congress appropriated the necessary funds for the establishment of this new department. Dr. Franklin C. Hunt and later Dr. Lauriston Taylor was in charge of this new x ray department and directed these epoch making developments. The unit idea was then presented to the European physicists in London in 1925 and later at the International Congress of Radiology in Stockholm, Sweden in 1928. The roentgen unit designated by the small letter r was universally adopted as the international standard of x ray intensity.⁶

The second phase of more accurate dosage application toward the goal of adequate radiation therapy in cancer had been realized.

DOUBLE CROSS ARM RADIUM VAGINAL APPLICATOR

The degree of homogeneity of the distribution of radium rays as employed by the various methods in treatment of cancer of the cervix in use at our hospital has been critically analyzed by means of photographic film studies and ionization measurements. Our observations might be helpful to others in visualizing the limitations and advantages of the various methods for obtaining the essential diffuse distribution of radium intensities and at least minimizing the dangers of localized vaginal wall necrotic areas or hot spots. Even temporary damage to the rectum, bladder and other normal structures can be avoided. There are exceptions of course when the primary lesion has already infiltrated neighboring vital pelvic organs; therefore we are presenting only a preliminary report of our radium distribution studies. Final conclusions cannot be made at this time.

Each capsule or point source of radium has a limited sphere of activity beyond which the cancer cells will survive even though the quantity of radium is increased tenfold. The uniform distribution of radium is more important than the quantity employed for each point source. In order to obtain the proper distribution of the radium to the cervix and parametrium at least some fixed form of multiple radium sources must be employed. The double cross arm metallic applicator (Fig 366) was found to be the most practical and effective method of introducing multiple radium sources within and around the cervical canal. The advantage of this method compared with

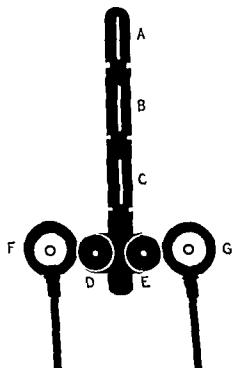


Fig 366—Double cross arm (DE) radium applicator. Walls equivalent to 1.8 mm of platinum. Adjustable intracervical stem containing three compartments for radium (ABC) wall thickness equivalent to 1.3 mm of platinum. Two colpostats (FG) are equivalent to filtration 2 mm of platinum.

the flexible rubber catheter was that the point sources of the radiation always remained constant. Malposition of the uterus was corrected by the use of the double cross arm applicator and thus the dangers of vaginal ulcerations and injuries to the bladder and rectum were minimized. Occasionally a contracted vaginal vault excludes the use of additional lateral colpostats (Fig 366 F G) but the advantage gained by their use cannot be overemphasized.

The filtration in the stem of this applicator was 1.3 mm of platinum, the crossarms 1.8 mm, the colpostats 2 mm of platinum equivalent. The average time of application was usually 100 hours when 10 mg of radium were placed in each of the compartments of the

double cross arm vaginal applicator (Fig 366 A B, C D E F) and in the lateral colpostat compartments (Fig 366 F G)

If 70 mg were employed the total application time would have been a total of 50 hours more or less. Depending upon the distribution of the cancer in the cervix occasionally 15 mg were placed in the C compartment while in a short cervix A could be eliminated altogether. The total radium dose approximated 6000 to 7000 mg hours applied continuously or fractionated over a period of 3 weeks. Our next problem was to determine the number of milligrams of radium each compartment should contain to meet the requirements of equal radium distribution sources and also take care of the needs

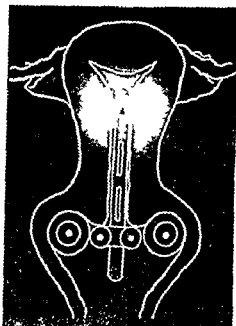


Fig 367—Cross arm vaginal applicator and colpostats in position within the cervical canal. Radium is shown in A.

of the cervical cancer lesion. Depending upon the length of the uterine cervical canal and extent of the cervical cancerous lesion respectively 10 to 15 or 70 mg of radium were employed. In the larger group of cases however 10 mg of radium were placed in the seven different compartments for approximately 100 hours. This appeared to be the ideal set up for the most effective and homogeneous distribution of the radium intensities in cancer of the cervix.

RADIUM DISTRIBUTION IN CERVICAL CANCER

We experienced considerable difficulty in finding suitable methods for demonstrating the radium distributional effects within the cervical canal and surrounding structures. A wax phantom was finally

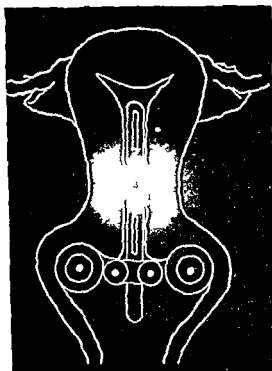


Fig 368—Radium is shown in B

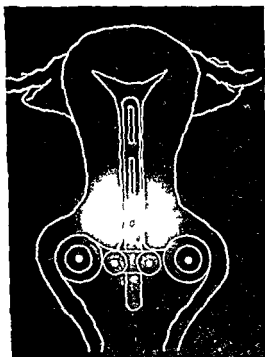


Fig 369—Radium 1 shown in C

constructed the size and shape of the average uterus. The double cross arm stem applicators and colpostats (Fig 366) were embedded

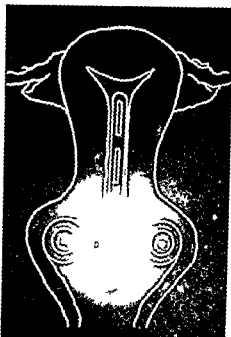


Fig 30—Radium in cross arms (DE)

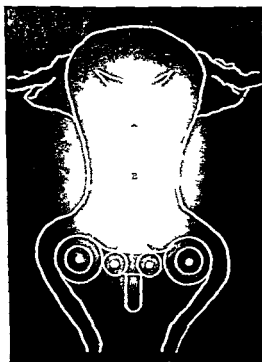


Fig 371—Radium in colpo rats (FG)

in this phantom or wax mold Radium was placed in compartment A (Fig 367) of the stem of the cross arm and a photographic film



3 -Radium shown in compartments (ABC) cross-arms (DE) and col postats (FG)



373 -Radium in compartments (ABC) Note ineffective cervical os radiation.

as exposed Six other 5 by 7 films were exposed to a like amount of radium in individual compartments respectively (B C D E F

G Figs 368 to 371) The approximate distribution of the radiation sources could thus be graphically visualized on separate films when exposed to the individual radium compartments of the cross arm applicator. When these exposed seven films were superimposed one upon the other the combined radiation effect was observed as shown in Figure 372.

Should radium be omitted in any one compartment the distribution factors would be disturbed and inadequate irradiation would result. For example when the intracervical tandem method was employed placing radium in the A, B and C compartments of the stem of the applicator (Fig. 373) the limited irradiation effect along the lateral margins of the cervix towards the parametria clearly indicated inadequate dosage and additional cervical vaginal vault contact radiation must complete the homogeneous cervical canal radiation.

DOSAGE RECORDS

One practical point should be emphasized at this time in reference to the physical factors of the reported dose of x ray therapy. Too many authors when recording dosages added the respective roentgen intensities delivered to the skin and then erroneously interpreted the combined surface roentgen as the tumor dose or amount of radiation reaching the supposed cancer bearing area. A recent publication mentions a total dose of 17,000 roentgens to the pelvis without further implication, another mentions 8000 roentgens as the dose applied to the neck for cancer of the larynx. If these techniques had been applied to a single area the skin would most certainly have been irreparably damaged. In reality the four areas of the anterior and posterior skin surfaces received but 3000 roentgens each. Smaller portals of entry or beam of x rays will allow a greater number of roentgens to be applied without serious damage to the skin surface than the large 20 by 15 cm. areas. A careful record of all the factors involved in a description of the quantity (air or surface dose in roentgens) quality of the rays h.v. * daily and total x ray dose delivered through each portal of entry must include reference to the size of the patient since the size of the abdomen indirectly predetermines the amount of effective (plus or minus) radiation reaching the tumor.

We have called attention to the indiscriminate recording of the x ray and radium dosages in some literature since it has been misleading leading to the inexperienced radiotherapist or over courageous cancer surgeon and unfortunately for all concerned could easily be misinterpreted and occasionally misapplied. Even among experienced colleagues in our cancer clinic the question has been critically discussed whether or not our radiation therapy methods have been adequate in view of the supposedly reported huge x ray and radium dosages recommended by other competent observers.

Half value layer & term notation of x ray penetration

The *timing* of the x ray or radium dose is an equally important consideration. Some conditions are more effectively treated by single massive doses of x ray. Deep seated malignant tumors may require either the prolonged or the intensive fractional form of treatments—perhaps as many as 35 daily applications. Still other malignant growths respond to the saturation technic of x ray therapy. All these application factors must be carefully considered and recorded in every case of cancer otherwise a true evaluation of the probable radiation effects upon the tumor cells cannot be obtained.

X RAY AND RADIUM EFFECTS COMPARISONS

Although x ray and radium rays have many physical qualities in common the direct or indirect effects upon tumor cells may differ.

When the erythema or initial skin changes of unfiltered x ray and radium are compared either form of radiation energy will cure a superficial cancer. Both methods possess individual inherent clinical therapeutic advantages.

When we evaluate the effects of the different sources of radiation in deep seated tumors we are confronted with definite physical handicaps in the use of topical radium application. In order to conserve the skin and intervening soft tissue the distance between the source of the x ray beam or radium element and the deep seated lesion must be increased otherwise the intervening tissue between the tumor and the skin will absorb most of the radiations at the expense of the tumor. Because of the necessarily increased focal skin distance the use of external radium is more or less impractical. The 10 gm radium bomb might be substituted for the high voltage form of x ray therapy but this more expensive procedure has many inherent disadvantages. Modern x ray therapy possesses greater potential intensities and more effective long distance radiation than topical radium.

CANCER OF THE SKIN

In the treatment of *superficial cancerous lesions* irradiation with x ray or radium proved to be equally efficacious. The absence of much scarring or improved cosmetic results apparently favors x ray therapy. From 1500 to 4000 roentgens (wbs *-hvl 1.0 mm aluminum) sufficed to eradicate most skin cancer lesions less than 5 cm in size.

In the semi deep and larger lesions we definitely prefer x ray to radium as the radiation agent.

When the tumor infiltrates the deeper structures causing fixation to the underlying wall and involving an area greater than 5 cm it was found helpful to employ a more penetrating quality of x ray radiation. The voltage and filters were increased from 100 kv to 200 kv (hvl equivalent from 0.1 mm of aluminum to 0.9 mm of copper). At the same time the total dose was both fractionated and increased.

With back scattering

from 3000 to 5000 roentgens (measured on the skin) This type of high voltage x ray for semi superficial skin lesions proved to be exceptionally effective when the cancer was complicated by infection. Under these conditions the total dose was administered over a 2 or 3 weeks period We found the divided dose method of x radiation more effective than the massive single application in these latter types of more extensive cancer infiltrations

For the *extremely large ulcerating inoperable semi deep skin tumors* the cross firing and tangential methods were always employed The x radiation beam was directed laterally from two to four point sources Occasionally a large surface cancer may have demanded increased irradiation of the outer margins—this was accomplished by placing a lead sheet in the center of the lesion during part of the exposure The center of the lesion was thus protected while the more resistant margins received the necessary adequate lethal dose Under these conditions the dose applied through each port varied considerably Usually 2500 roentgens directed tangentially through two or four ports sufficed

When local recurrence followed the use of either radium or surgery heavily filtered divided x radiation was the treatment of choice However the majority of the carcinomas of the skin (5 cm or less in size) were cured by the intensive or divided massive dose method with either radium or roentgen rays

Angiomas of the superficial skin responded to either freezing with carbon dioxide radium or x radiation therapy Careful attention to the technical details in all these measures was important from both a curative and cosmetic standpoint

In radiation therapy of the *deeper cavernous types of hemangiomas* we followed the practice of employing relatively small doses of from 150 to 300 roentgens per treatment (200 kv hvl 0.25 mm copper) as measured on the skin every 6 weeks When the lesion indicated early blanching x ray therapy was deferred or the intervals between the treatments increased This was an important observation and applied equally to radium therapy procedures

Extremely large and relatively deeper angiomatous lesions were unquestionably more effectively treated by the surface crossfire or tangential method of x radiation especially when the lower extremities or any curved skin surfaces were involved

The radiation treatment of superficial lesions has been uniformly more successful than for the more advanced and deeper cancers Nevertheless when a superficial squamous cell lesion is in close proximity to vital normal structures involving for example the inner canthus of the eye a combination of fractionated timing and variable filter methods of x ray or radium applications was the essential factor in the treatment Thereby a cure without injury to the normal eye structures was effected with good cosmetic results A single massive

dose would likewise cure the cancer but not without probable injury to the normal structures

CANCER OF THE BREAST

Since the preoperative x ray treatment of carcinoma of the breast requires special consideration the axillary and supraclavicular fields were irradiated directly with approximately two thirds of the usual skin tolerance dose with 1250 roentgens as measured on the skin (200 kv hvl 0.9 mm copper). The breast tumor was irradiated indirectly by means of the tangential or surface cross fire method with approximately the same 75 per cent x ray dose administered preliminary to the surgical removal of the breast cancer. As a result the underlying lung structures as well as the superficial skin surfaces were protected and conserved. Postoperative healing complications supposedly due to preliminary x ray therapy were rarely encountered.

On the other hand in the cases of inoperable breast cancer the largest fractionated dose possible was employed. In the average breast lesion the tumor mass axilla and supraclavicular regions received 1500 to 2500 roentgens at 200 kv (hvl 0.9 mm copper) the daily dose being 150 to 250 roentgens. When the inoperable breast tumor was superficial and involved only the skin the penetration of the x ray beam was reduced to hvl 0.2 mm of copper and a total roentgen dose of 1500 to 1800 roentgens. The dose was repeated at intervals of 6 or 8 weeks.

The selection of the proper treatment method and dose was especially important in all postoperative breast lesions. When feasible we again preferred the tangential or superficial cross fire method of directing the rays along the surface of the operative field. The less penetrative form of 200 kv x ray therapy (hvl 0.2 to 0.5 mm of copper) 1500 to 1800 roentgens was our postoperative dose. The direct axillary and supraclavicular fields may require deeper x ray penetration by increasing the radiation to the equivalent of hvl 0.9 mm of copper.

Preoperative and postoperative irradiation and the irradiation of nonoperable breast cancers demand individual dosage consideration. Depending upon the type of cancer extent of the axillary and supraclavicular nodes and the initial skin response additional x ray therapy may or may not be indicated in the inoperable and the operable groups after surgery. Over radiation of an apparently hopeless recurrent breast lesion is to be guarded against.

CANCER OF THE LARYNX PHARYNX AND TONSILS

In the treatment of laryngeal pharyngeal and tonsillar malignant neoplasms the ideal objective is completely to sterilize the radio sensitive cancer cells with a minimum of damage to the less radio sensitive surrounding normal structures.

In order to accomplish this the patient must be examined carefully every day while under treatment. The radiation reactions of the normal and pathological tissues apparently serve as an important guide to the clinical management of the case. The more highly differentiated tumors are definitely more radioresistant than those graded histologically as undifferentiated.

The ultimate criterion of radiosensitivity of cancer cells however is largely dependent upon their clinical response to the applied radiation. Lesions that are resistant to the old type of x-ray therapy irrespective of the histologic grading of the cancer are found occasionally to be clinically sensitive to the more modern dosage procedures. Nevertheless the technic of external radiation therapy is varied in conformity to the histologic type and site as well as the distribution of the lesion.

According to Regaud 20 to 25 daily treatments of heavily filtered x-rays are optimum for the irradiation of a tumor. Coutard and others prolonged the daily treatments to 5 or 6 weeks. We do not attempt to standardize the daily or even the total treatments, but individualize the many factors of the dose to meet the needs of the type, extent and location of the cancer.

In all our procedures for laryngeal, pharyngeal and tonsillar x-ray therapy we employ unusually heavy filters and voltages (hvl 225 mm to 55 mm copper). The daily treatments vary from 250 to 350 roentgens with periods of intermission when the radio-epithelitis and other changes are observed along the mucous linings of the lesion. The total average dose for each of the two 7 by 10 cm. fields varies between 3500 and 5000 roentgens (200 kv hvl 225 mm copper). Occasionally both the number of fields and the total dose are increased.

CANCER OF THE CERVIX

Cancer of the cervix demands a greater number of and a more complex combination of radiation techniques than perhaps any other single cancer. For many years we have studied these various methods, their practical application and the results obtained therefrom.

Effective irradiation of cancer of the cervix depends in a large measure upon the homogeneous distribution, proper timing and coordination of the x-ray and radium treatments. Even in early cancer parametrial extension to the deeper pelvic lymph nodes is a threat. I will discuss this question later after analyzing the advantages and disadvantages of administering x-ray therapy prior to the use of radium in the cervical canal.

Preliminary X-ray Therapy—In the average case of cancer of the cervix x-ray therapy is externally applied routinely throughout the entire pelvis and especially directed to the vital parametrial regions preliminary to and following the intracervical application of radium.

We are satisfied that this procedure definitely decreases the chances of a recurrence of the growth

Since the presence of infection apparently increases the radioreistant state of malignant tumor beds the more extensive malignant ulcerated infiltrations of the cervix also invariably receive preliminary x radiation which favorably influences the local infection. Complete disappearance of the infection and the primary cancer occasionally follows this treatment

When external radiation was properly administered severe clinical reactions rarely followed the application of intracervical radium. Contractions of the cervical canal were sometimes observed however when the time elapsing between the preliminary x ray applications and the radium applications had been prolonged beyond 8 weeks. We therefore concluded that except in selected cases of stage I or II cancer of the cervix radium should not be applied earlier than 3 weeks nor later than 6 weeks after preliminary x ray therapy. This also applies to the direct intravaginal cone or contact x ray therapy. Occasionally both the x ray and radium intracavity applications are omitted if the response to preliminary external roentgen therapy appears to be unfavorable

Tumor Dose—There is much confusion in the average expression of radiation dosage. Many of the essential physical and technical x ray and radium factors are frequently omitted when recording the radiation dose. Preliminary calculations of a predetermined course of treatments with calibration studies of the depth and intensity charts or the actual direct measurements of the roentgen dose at the site of the tumor are essential preparatory considerations. Without them adequate therapeutic radiation might not be delivered to the tumor. Maximum lethal tumor damage and minimum injury to the normal structures are the anticipated accomplishments when depth measurement procedures are given the proper consideration

In deep seated uterine cervical cancers we merely prescribe the tumor dose or number of tissue roentgens desired at the site of the lesion. We never mention the method to be employed or state the number of ports of entry. The ports of entry and the focal skin distance are increased until the tumor bed and pelvic glands receive approximately 3500 tissue roentgens. When the treatments are completed all of the physical technical factors to produce effective pelvic irradiation are included in our history records. The penetration and quantity factors of the average x ray beam are increased or decreased in order to fulfill the requirements of such a tumor site dose

Although the size of the patient is of secondary consideration in surgery or in intracavity radium applications it is vitally important in roentgen therapy. For the average thin patient two ports of entry are sufficient. On the other hand a larger patient requires a more in

tensive external dose and three to six additional ports of entry may be necessary. It is thus important to predetermine accurately preferably by direct intracervical measurements the anticipated total amount of irradiation reaching the glandular and parametrial structures of the pelvis otherwise the tumor will receive but a portion of the required lethal dose when we attempt to penetrate through the tissues of a large abdomen and the tumor bearing areas will unquestionably remain under irradiated unless we had made adjustments by increasing the external radiations.

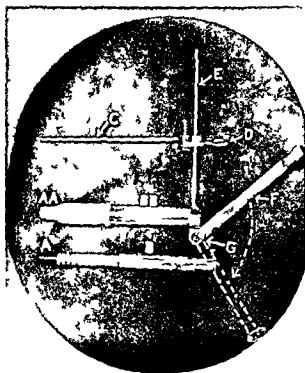


Fig 374—Vaginal speculum (BB) Rubber fingercoat (AA) for protecting thimble ionization chamber (A) when chamber carrier (B) is inserted into Foot (F) at hinge (G) when turned down against table top supports speculum in position during measurement of x ray dose.

The surface pointer (C) can be raised or lowered by releasing thumb screw (D) on centimeter scale (E).

Direct Vaginal Tumor Dose Measurements—For the direct measurement of the tumor dose a small vaginal tube speculum (Fig 374) was designed for insertion directly into the vaginal vault. This was a practical ionization thimble chamber speculum holder for measuring the number of tissue roentgens absorbed per minute at the site of the cervical lesion during the actual treatment period of the patient. The x rays strike the standard Victoreen thimble ionization cham-

ber *A* when introduced into the vaginal speculum holder *BB* which is enclosed in a sterile rubber finger cot *AA*. This measuring chamber is held in a fixed position while the x radiations are passing through the abdomen to the tumor and to the ionization chamber *A* within the vaginal holder *AA*. When the thumb chamber *A* is removed the exact x ray dose per minute can be read on a calibrated scale in roentgen units.

The end of the pointer *C* (Fig. 374) can be raised and lowered on the graduated scale *E* for measuring in centimeters the actual distance between the abdominal wall and cancer area to be irradiated. The end of pointer *C* also localizes the position of the cervical tumor. Handle *F* at hinge *G* facilitates leveling, fixing and keeping the speculum in position during the period of making the preliminary roentgen measurements.

For example, in a large patient the direct intravaginal tumor dose may read 10 roentgens per minute as compared to 20 roentgens in a thinner patient. This difference is accounted for by the intermediate absorption of a part of the roentgen energy by the superimposed abdominal muscles and other structures. In either case the extrinsic skin doses in roentgens are identical yet only half of the total primary beams of x ray reaches the tumor. Hence it is essential that these preliminary direct measurements or indirect calculation of the dose from charts or both be made prior to administering pelvic roentgen irradiation. Prognosis as to the final outcome is especially dependent upon reliable dosage data and effective roentgen applications but even more directly upon the predetermined measurement or knowledge that the live tumor growing cells and parametrial regions of the pelvis receive a lethal dose of roentgen energy. Having these known factors of the actual tissue tumor dose in mind together with favorable clinical evidence of the response of the malignancy to the radiation a reasonably sound basis for venturing the prediction of a probable cure of the lesion is at our command.

Prognosis—Early reduction in the size and extent of the cervical tumor to preliminary roentgen ray therapy is an encouraging sign of a favorable outcome and conversely the absence of this early response is an unfavorable sign.

In attempting to study these index features biopsies were obtained prior to and after the preliminary roentgen ray treatments and again after the radium applications and the effectiveness of the preliminary x ray treatments upon the cervical lesions was carefully tabulated and analyzed. In the groups which were nonresponsive to x ray therapy the addition of radium apparently failed to change our preliminary unfavorable prognostications. Relatively few of these cases remained cured after 5 years. The early responses were also found to be reliably significant for estimating the type and form of the future therapeutic procedures. However, the state of the disease biopsy evalu-

tions and other clinical features were given equal consideration before venturing a final prediction as to the probable outcome.

We have concluded therefore that unless the initial response to x ray therapy is promising and the ulceration or fixation of the malignant cervical structures is not too far advanced intracervical radium procedures should be abandoned altogether. Frequently radium applications in advanced cancer of the cervix have been observed to be more harmful than helpful even as a palliative measure. The cervical stump is usually eroded and the cervical canal occluded to the extent that the application is limited to the vaginal vault. X ray therapy in divided doses is of definite value as a palliative measure in these cases, including those with metastatic lesions in pelvis and bone.

In the cases which respond favorably to the preliminary x ray treatments the intracervical application of radium is indicated and remains one of the most effective methods of obtaining unlimited lethal changes within the cancer bearing area. Recent developments in the intravaginal x radiation by means of small cones or contact x ray tubes also possess great possibilities. Attention to detail of its application is vitally essential in order to avoid under as well as over radiation.

The indiscriminate application of multiple tubes of radium of different strengths into the cervical canal by anyone lacking technical radium knowledge is not only unwise but dangerous. Especially is this true when the physician's sole reliance is placed on the technical directions enclosed in the package of rented radium received the morning of the operation. No one is competent to offer reliable directions for the application of a safe and effective dose of radium without having made a careful preliminary physical and vaginal examination of the patient and microscopic analysis of the biopsy.

SUMMARY

1 It should be more generally recognized that therapeutic radiations possess powers of producing directly and indirectly varying degrees of physical, chemical and biological changes in tissue cells.

2 The successful management of cancer is not solely dependent upon elaborate surgical, roentgen or radium equipment but equally upon clinical experience, radiation judgment and cooperation of the various medical fields interested in the treatment of malignant diseases.

3 From a practical standpoint the ultimate criterion of radiosensitivity of cancer cells is their clinical response to known radiations.

4 The indiscriminate recording of x ray and radium dosages in some literature is a serious problem and may be inaccurate, misleading and unfortunately misapplied by the inexperienced in the treatment of cancer.

5 The therapeutic requirements in cancer of the cervix demand a greater number of complex combinations of x ray and radium techniques than perhaps any other single cancer problem.

6 The proper timing of the administration of x ray or radium rays and the selection of an effective number of penetrating roentgens for an adequate radiation dose are equally important factors in the therapeutic management of malignant diseases

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A STUDY OF 106 CASES OF MULTIPLE PRIMARY SKIN CANCER

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ALTHOUGH only 1.6 per cent of all deaths from cancer are due to cancer of the skin¹ the actual incidence of skin cancer is much higher than this figure would lead one to expect. The incidence of skin cancer varies rather markedly for different geographical locations. In the United States it is much higher in the southern states than in the northern. For example, the Public Health Service studies^{2, 3, 4} have shown that in New Orleans, Louisiana, 26 per cent of all cases of cancer among white males were cancer of the skin; in Atlanta, Georgia, 38.5 per cent; and in Birmingham, Alabama, 43.3 per cent. Comparable statistics for three northern cities^{5, 6} (Detroit, Michigan, Chicago, Illinois, and Pittsburgh, Pennsylvania) were 12.3 per cent, 12.5 per cent, and 16 per cent respectively. The high incidence of carcinoma of the skin in the southern states, where there is brighter sunlight and longer summers, is thought to indicate the importance of sunlight as a causative factor in carcinoma of the skin.

This is not a new idea, however, since Watkins Pitchford⁸ in 1909 attempted to prove that cancer was caused by an illumination in excess of that which can be dealt with by the protective agencies of habit, posture, coverings, and external pigmentation. In addition, in 1918 Paul⁹ stated that the most important cutaneous lesions in Australia, from the point of view of prevalence and destructive effects, was carcinoma. He believed that the most significant causative factors of these lesions are the actinic rays of light and that the most significant inhibiting factor is the pigment deposits in the skin.

Multiple skin cancers often occur, especially in patients who have had prolonged exposure to sunlight, but in the studies on regional incidence no separation of cases in which there were multiple skin lesions was made. Phillips¹⁰ has reported studies on multiple primary carcinomas of the skin seen at the Scott and White Clinic at Temple, Texas, but similar reports have not been numerous. It was thought, therefore, to be of interest to present data on 106 cases of multiple primary cancers confirmed by microscopic examination, which were seen at the Barnard Hospital clinic during a 5 year period (June 1936 to June 1941).

During this period a total of 1790 cases of cancer of the skin were seen, and in 106, or 5.9 per cent of these cases, the patient had mul-

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multiple primary lesions All the patients with multiple skin cancer in the group reported here are white. Only cases in which the diagnosis was confirmed by microscopic examination are included in this series. These figures would be considerably higher if those cases which were treated by cautery excision without removal of tissue for microscopic examination were included. Lesions of the lower lip, penis, vulva and anus are also excluded from this study. Melanomas in which satellite lesions and multiple skin recurrences and metastases are the rule have also been excluded from this series since in such cases there is usually only one *primary* lesion.

EXPOSURE TO SUNLIGHT AND MULTIPLE CUTANEOUS CANCER

The number of multiple lesions of the skin seen in the Barnard clinic is very much lower than that reported by Phillips for the Texas clinic. Out of a total of 1400 cases of skin cancer which he reported 226 persons or approximately 16.1 per cent had multiple cutaneous cancers whereas only 5.9 per cent of the Barnard cases of cutaneous cancer have multiple primary lesions. Two factors may play a role in explaining this difference in incidence. (1) St. Louis is farther north than Temple, Texas, and hence has less direct actinic rays and shorter summers and people living in this area are therefore less exposed to direct sunlight. (2) the Barnard clinic is in the center of an urban area so that most of its patients are not engaged in outdoor occupations in which they would be subjected to long exposures to the sun. Since most of the patients included in this study were old people many were unemployed. Of the 106 patients with multiple skin cancers only 54 stated their occupations. Of these 54 patients 29 or 53 per cent were farmers, gardeners or laborers. Thus over half of these patients were persons whose work had necessitated prolonged exposures to sunlight. This percentage corresponds almost exactly with that reported by Phillips who found that 52.4 per cent of his patients with multiple cutaneous cancer whose occupation was known were farmers and ranchers.

SEX INCIDENCE

Of the 106 cases of multiple cutaneous cancer studied in the Barnard clinic 81 were men and 25 were women, a ratio of 3.2 to 1. In all statistics reported on cancer of the skin men are shown to be much more prone to develop skin lesions than are women. From this series of cases and also from Phillips' series men are seen to be also more likely to develop multiple skin lesions than are women. The difference in sex incidence is difficult to explain. One factor that may play a role is that women are less exposed to carcinogenic agents such as chemical and physical trauma (of which sunlight is one) because of their more sheltered occupations.

AGE INCIDENCE

In both men and women multiple cutaneous cancers are usually found in older individuals. In 75 of the 106 cases (71 per cent) the patients were over 65 years of age. The youngest patient in the series was 44 years old and the oldest 91 years. The average age of the entire group was 69 years. Phillips also found that the highest incidence of multiple lesions occurred in the sixth decade of life. Cancer of the skin, whether the lesions are single or multiple, is of course primarily a disease of old age.

FAMILY HISTORY

In most of the cases in this series detailed family histories were not available. However, 16 of the 106 patients knew of other cases of cancer in members of their families. Eight had relatives who had also had skin cancer, 8 knew of other members of their families who had had carcinoma of other organs. The numbers involved are too small to be of statistical significance, but it is interesting that even in this small series 15 per cent of the patients had a family history of cancer. In many of these cases no family history was taken. Perhaps if this point had been more carefully checked in all cases, the number of patients found to have a family tendency to develop cancer would have been even higher.

LOCATION OF LESIONS

A total of 290 malignant lesions were examined microscopically in the series of 106 patients. The highest number of lesions for any one patient removed during the 5 year period considered in this report and examined microscopically was 11. Most of the lesions occurred on exposed areas of the body: 269 were on the face and neck, 12 on the dorsa of the hands, 3 on the arms, 3 on the back, 1 on the chest, 1 on the scalp and 1 on the thigh. Thus 96.9 per cent of the lesions occurred on the face, neck and back of the hands. Phillips also found the face and neck to be the anatomical sites most frequently involved with the dorsum of the hand next in frequency. This finding likewise lends support to the theory that *exposure to sunlight* is an important factor in the production of skin cancer, since the number of lesions occurring on unexposed portions of the body is negligible.

In this connection it is interesting to note that Negroes have a lower incidence of skin cancer than do white persons, presumably because the pigment in colored skin acts as a protective agent against sunlight. In Quinland and Cuff's¹¹ series of 11 cases of cutaneous cancer in Negroes 5 or 45 per cent were on the exposed skin. Howles¹ has shown that in 58 colored patients with skin cancer only 41 or 71 per cent of the lesions involved the exposed surfaces, and Schreil¹² in a study of 20 colored patients with cutaneous cancer has shown that only 12 or 60 per cent of the lesions were on the exposed sur-

faces of the skin. Thus there is a definite racial difference in the localization of cutaneous carcinoma. White patients who have no protective pigment have a much greater incidence of cutaneous cancer on exposed areas of the skin than do Negroes but Schrek¹³ has shown that carcinoma of the covered skin has the same incidence in the two races.

DURATION OF LESIONS

The duration of the lesions in the Barnard series as obtained from the patients' histories varied within broad limits. One patient stated that one of his lesions had been present for only 2 weeks while another patient claimed that one of his lesions had been present for 60 years. Such data is of course quite undependable. It does show, however, that although some squamous cell carcinomas of the skin may be highly malignant and grow and metastasize rapidly, other lesions, usually basal cell carcinomas, may be present for many years without seriously inconveniencing the patient.

Twenty-two of the patients reported in this series or 20.6 per cent had more than one clinic or hospital admission in the 5 year period considered in this report. The interval between admissions usually extended over a period of a year or more. One patient, 67 years old, who at the time of admission had carcinomas of the left cheek, the right cheek and the right ear, gave a history of having had a cancer of the right temple removed 19 years previously. Another patient had been followed in the Barnard clinic since 1930 when he was 51 years old. In 1930 he had had 7 carcinomas of the face treated with radium. The lesions were located on the upper lip, right inner canthus, the temple, the left lower eyelid, the nose, and two on the left side of the neck. In 1934 carcinomas were removed from the skin over the left mandible, the forehead, and the cheek below the left eye. In 1936 skin cancers were excised from the chin and the right side of the neck and from in front of the left ear. In 1941 this patient was again seen and many new lesions on the face and the right ear were cauterized. In 1943 he came again to the clinic and skin cancers were excised from the forehead, the right lower eyelid, and the skin of right zygomatic area. As Phillips has pointed out, such observations indicate the notable tendency of some persons to continue to have skin cancer and show that, no matter how effective the therapy, we cannot stop the formation of new lesions.

HISTOPATHOLOGY

Microscopic examination of the 290 lesions removed from the patients in this series showed 161 to be basal cell carcinomas, 90 squamous cell carcinomas, 26 basosquamous cell carcinomas, 5 hair follicle carcinomas, 1 an intra-epidermal carcinoma, 1 a nevo carcinoma, 2 carcinomas of sweat gland origin, one an undifferentiated carcinoma, and 3 fibrosarcomas. An analysis of all the cases in this series shows

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some tendency for an individual to develop lesions which are of the same microscopic type. Of the 106 patients 49 or 46.2 per cent, had lesions which were of different microscopic types while 57 patients, or 53.8 per cent had lesions which were all of the same microscopic type. In 38 patients or 35.8 per cent of the total number of cases all the lesions occurring in any one individual were basal cell carcinomas in 16 patients or 15.1 per cent all the lesions in any one individual were squamous cell carcinomas and in 3 patients or 2.9 per cent all the lesions were basosquamous cell carcinomas. Thus basal cell carcinoma is the type encountered most frequently in patients with multiple lesions making up 55.5 per cent of all lesions encountered. This figure corresponds fairly closely with that reported by Phillips who found that 52.9 per cent of all the lesions in his series were basal cell carcinomas. Only 31 per cent of the total number of lesions in the Barnard series were squamous cell carcinomas while Phillips found 44 per cent of the lesions in his series to be squamous cell carcinomas.

FOLLOW UP OF PATIENTS

As has been previously mentioned the cases included in the Barnard series were seen in a 5 year period extending from June 1936 to June 1941. In January 1944 2 1/2 years later a check was made to see what the subsequent history of these patients had been. Of the 106 patients 21 had died, 23 had returned to the clinic with new lesions, 11 had been seen at least once in the interim and no new lesions had been present and 51 had not been seen since June 1941. Of the 21 who had died in 7 the cause of death was attributable to carcinoma of the skin from metastases or extension. Two had died of cancer of other organs, 1 of a primary carcinoma of the liver the other of carcinoma of the ovary. Twelve had died from other causes. Thus in this group of 106 patients 6.6 per cent had died of skin cancer but in even higher per cent (11.3 per cent) had died of other causes.

Of the 55 patients on whom a follow up was obtained approximately half have had new skin lesions within the 2 1/2 years that have elapsed since this study was made. One patient has had 8 new lesions on the face. Another patient who had had his right forearm amputated in 1940 for an extensive carcinoma of the back of the hand has had a right axillary dissection for metastatic carcinoma. He had also had a lesion cauterized on the back of the left hand in 1940 which was incorrectly clinically diagnosed keratosis. Metastases from this lesion were subsequently removed from the left axilla. In addition this patient has had 5 new lesions (4 basal cell carcinomas and 1 squamous cell carcinoma) removed from the face and neck all of which have appeared since June 1941 as well as a squamous cell carcinoma on the stump of the right arm. Only 11 of the 55 patients followed or 20 per cent have not had new skin lesions. Thus although multiple skin

cancer does not carry a high mortality there is a tendency for new lesions to form rapidly despite adequate treatment Many of these lesions tend to recur and others to metastasize to regional lymph nodes

SUMMARY

Multiple skin cancer does not differ from solitary cutaneous cancer in age incidence sex incidence or location of the lesions Multiple lesions are also of the same histologic types as are single lesions What are the attributes of one type of skin which produces multiple lesions under apparently similar environmental conditions in which another type of skin produces only single lesions? Susceptibility to the action of sunlight on the skin may be one factor operating in such cases but the full explanation still remains obscure

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LIGHT AS A FACTOR IN SKIN CANCER

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EWING has stated that the most important cause of skin cancer is exposure to sunlight. While we know that other causes of skin cancer may be injury, infections, exposure to tars and chemicals, and even single wounds, nevertheless the impression of most dermatologists is that chronic exposure to the actinic rays of the sun is the most important exciting etiologic factor.

In the last 20 years sun bathing has grown from a fad to what almost amounts to an obsession. It cannot be denied that there is some virtue in exposure to the sun's rays. However, living in the outdoors, exercise, and relaxation are probably the most important factors. It is quite difficult to trace any specific stimulating action from exposure to sunlight, but one cannot deny the existence of this effect. We know that sun exposure is an aid in the cure of rickets, some infectious skin diseases, and in tuberculosis of the skin.

If we disapprove of excessive sun bathing, it is of course not necessary to forbid moderate exposure, but many dermatologists have observed an increase in the number of cases of cancer in individuals below the usual cancer age who had exposed themselves excessively to sunlight.

Nature has provided some very definite means of protection against sunlight. Many animals have heavy coats of hair which serve to filter out the actinic rays, thus protecting them from excessive exposure. The tropical races of man are provided with pigmented skin. The yellow, the bronzed, and the black pigment deposits seem to serve the same filtration purpose. Some of the tropical races may even have internal mechanisms which protect them against the deeper effects of actinic exposure which the white races apparently do not possess. Our knowledge of these deeper effects is meager. They are very complex and involve the processes of pigmentation, photodynamics, photosensitization, and photoimmunization. There are indications that actinic rays have some effect on blood formation and destruction, upon the internal secretions, upon the utilization of vitamins, upon liver function, and upon the autonomic nervous system.

There seem to be three independent photodynamic processes in the normal human skin brought about by wavelengths included in sun-

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light (1) the sunburn mechanism which comprises a series of events resulting from damage to the stratum germinativum principally the prickly cells (2) the antirachitic action by which certain sterol compounds are changed into vitamin D or other antirachitic substances (3) processes for the darkening of pigment only present in a colorless form It is doubtful as to whether or not this latter mechanism plays a part in tumor production because its active spectrum lies between 3000 and 4000 angstroms The tumor producing wavelengths are approximately between 3700 and 2900 angstroms

PATHOLOGIC EFFECTS OF SUN EXPOSURE IN MAN

The terrific itching blistering malaise and fever that accompany severe sunburn are sometimes explained by the release of histamine in the skin It may be possible that continuous minor degrees of such poisoning may induce chronic skin reactions or disease

The chronic effects of sunburn are usually much more serious So called actinic eczema may be produced Some cases of acne may be exaggerated by sun exposure Furunculosis may be induced Recurrent solar urticaria prurigo solare lupus erythematosus and recurrent vesicular eruptions such as hydroa aestivale are all either activated or exaggerated by exposure to sunlight

Freckles are a common effect in many people They are exaggerated of course in the very fair skinned individuals Some individuals are so sensitive to sunlight that their freckles become malignant lentigo which may lead to cancer and death

Chronic exposure over a period of years leads to the well known sailor's or farmer's skin with its freckling telangiectasia keratoses and carcinoma When individuals inherit a skin that is extremely sensitive to light the aging process may begin in early life resulting in xeroderma pigmentosum

EXPERIMENTAL PRODUCTION OF TUMORS BY ULTRAVIOLET IRRADIATION

Tumors in laboratory animals have been produced by ultraviolet radiation Since 1928 several observers reported the production of tumors in rats and mice by the use of mercury arc radiation In the years following a number of other observers produced tumors in laboratory animals by ultraviolet radiation of various types and even by natural sunlight The tumors are commonly produced in those areas which have the least hair usually on the ears nose tail paws and also in artificially depilated areas Both carcinomas and sarcomas have been reported and papillomas were frequent in occurrence

Tumor formation in animals is restricted to exposure to that spectral region which produces sunburn and actinic reaction As already indicated it appears that only wavelengths between approximately 3200 and 2900 angstroms can produce tumors a circumstance confirmed by several investigators

LIGHT AS A FACTOR IN SKIN CANCER

RICHARD S. WISS, M.D.* AND ADOLPH H. CONRAD, Sr., M.D.†

EWING has stated that the most important cause of skin cancer is exposure to sunlight. While we know that other causes of skin cancer may be injury, infections, exposure to tars and chemicals, and even single wounds, nevertheless the impression of most dermatologists is that chronic exposure to the actinic rays of the sun is the most important exciting etiologic factor.

In the last 20 years sun bathing has grown from a fad to what almost amounts to an obsession. It cannot be denied that there is some virtue in exposure to the sun's rays. However, living in the outdoors, exercise and relaxation are probably the most important factors. It is quite difficult to trace any specific stimulating action from exposure to sunlight, but one cannot deny the existence of this effect. We know that sun exposure is an aid in the cure of rickets, some infectious skin diseases, and in tuberculosis of the skin.

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Tumor formation in animals is restricted to exposure to that spectral region which produces sunburn and actinic reaction As already indicated it appears that only wavelengths between approximately 3200 and 2900 angstroms can produce tumors a circumstance confirmed by several investigators

Another factor which apparently plays a part in the production of tumors is the total energy carried by ultraviolet radiation. It appears that the energy requirement is roughly 103 ergs per square centimeter per second using a wavelength shorter than 3150 angstroms. In animals very long exposure at this energy level was necessary to produce the tumors. The exposure was of the order of 5 hours daily over a period from 7 to 9 months. One must also take into account barometric conditions and the difference in spectral distribution of the mercury arc lamp and sunlight.

Only rats and mice have so far been found to be susceptible to tumor formation by ultraviolet radiation. The susceptibility seems to vary with different strains. Albino mice seem to be more susceptible. Pigmentation of the darker strains of mice apparently serves to filter out some of the effects of radiation.

Seelig and Cooper concluded that white light is not a necessary factor in the development of rat cancer in mice but their experiments do not eliminate the possibility that light may be a secondary factor in the genesis of experimental cancer.

Taussig, Cooper and Seelig in earlier experiments found that the incidence of skin cancer in a group of mice exposed to a sunlamp contrasted with a similar group kept in the dark was not sufficiently marked to warrant drawing dogmatic conclusions.

INCIDENCE OF SKIN CANCER

It seems to be the impression of clinicians that skin cancer is more prevalent in those regions of the earth that receive the greatest degree of sunlight. It is difficult to interpret the statistics that have been presented because there are few data on the intensity of the tumor producing wavelengths in different geographical areas of the earth. It is possible of course to estimate the total distribution of sunlight with some accuracy but it is almost impossible to estimate this light from the standpoint of the wavelengths which produce tumors. Atmospheric factors such as dust, smoke and water vapor may filter out the effective rays and this filtration may be increased by the angle which the sun's rays take when passing through the earth's atmosphere. In high northern or southern latitudes filtration by the much greater distance which the rays have to travel through the air is quite obvious.

Such measurements have not been made which may permit comparison of intensities of solar radiation falling on various portions of the earth until such measurements have been made correlation of the cancer incidence with geographical distribution of sunlight remains a matter of speculation. It is quite possible however that such a correlation ultimately will be found. If so a high cancer incidence should be found in those latitudes where the atmosphere is particularly clear. That this may be expected is evident from the reports of Australian observers who report a high incidence in cancer of the

skin in that area and believe it to be due to the extremely torrid insolation and the lack of water vapor in the atmosphere. In one Australian hospital it was stated that 25 per cent of admissions for cancer are cases of skin cancer. Dermatologists in the southwestern areas of the United States have the same impression. Apparently this is also true of southeastern United States. The incidence of cancer of the skin according to one observer is three to four times as great in Atlanta as in Chicago. A report on the occurrence of cancer in the United States Army and Navy indicates that cancer occurs much more frequently among the personnel who were born and who spent their early years in the southern states. However factors other than sun exposure may play a part in this.

It seems to be the consensus that the occurrence of human skin cancer is chiefly on the face. One report for instance states that 91 per cent of 1626 cases occurred in that area. On the basis of such impressions and reports one would be inclined to think that sunlight was the chief factor in view of the fact that the face is more exposed to the sun's rays than any other part of the body. Furthermore certain areas of the face are more susceptible than others for instance the absence of cancer in the submental area where the sunlight does not hit is impressive. Hats or head covering may shade portions of the face even the hair may shade the ears and that may account for the scarcity of epithelioma of the ears in women. Taussig and Williams called attention to the fact that the forehead of women is less exposed to sunlight than that area in men. Cancer of that skin area in women is extremely rare.

It seems to be true that certain regions of the skin are more susceptible to cancer than others and the conclusion usually reached mostly on a clinical basis is that the reason for the appearance of skin cancer in the exposed areas is chiefly sunlight.

This discussion would not be complete without an examination of the dictum of dermatologists that skin cancer appears more frequently in blondes than in brunettes. Taussig and Williams devised quantitative measurements which seem to indicate that certain characteristics of skin color are associated with cancer. It is quite a common report that cancer of the skin is rare among Negroes. Shamberg has called attention to this. Everett Linn has never seen a skin cancer in an American Negro. Roffo reported from Argentina that all of his cases of skin cancer were in farmers or foreign families but none were of Indian or Negro blood.

Confirmation of the belief that cancer of the skin occurs more frequently in outdoor workers than in those whose occupations keep them out of the rays of the sun is obtained from the report of Peller and Stevenson. The figures indicate that mortality from cancer of the skin and lip is approximately three times as high for the United States Navy as for the average population of the same age group.

CONCLUSIONS

Clinical impressions of investigators who have seen a great many cases of skin cancer indicate that sunlight is one of the factors responsible for its appearance. That the sun's rays are not the ultimate cause of cancer but that they are the precipitating cause is a tentative conclusion that has some validity.

Animal experimentation gives considerable support to the concept that rays in certain regions of the spectrum may produce cancer but it is not quite valid at the present time to translate conclusively animal skin effects to human skin effects. However, since the wavelengths that produce animal tumors are the same wavelengths that principally affect human skin, one is justified in assuming that they play a role in cutaneous cancer.

The mechanism of tumor production by solar and artificial ultraviolet radiation requires much more experimental work before it can be completely understood.

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BOWEN'S DISEASE AN INTRA EPIDERMAL CARCINOMA

Report of Cases from The Barnard Free Skin and Cancer Hospital

WALTER C. HEROLD, M.D. * AND JOIA K. COOPER, Ph.D. †

INTRODUCTION AND REVIEW OF LITERATURE

BOWEN'S disease is a rare but important condition. Although its clinical appearance is one which could easily be dismissed as some vague skin disease, it is potentially a squamous cell carcinoma. Unfortunately, the general concept of the disease is quite confused and no doubt its rarity is due in some degree to misdiagnosis.

Bowen¹ in 1912 first described 2 cases of atypical epithelial proliferation which he designated as a precancerous dermatosis. In 1915 he reported an additional case. In 1914³ and 1920⁴ Darier reported 4 cases and classified them as one of the dyskeratoses, a term which he considered represents a faulty development of the epidermis in the course of which a certain number of malpighian cells become isolated and differentiated from their fellows undergoing an abnormal premature and imperfect keratinization.

Since the publication of these first cases, numerous others have been reported. In 1930 Nicolas Massia and Rousset found 64 cases in the available literature of which 14 or 22 per cent were on the mucous membranes. No one investigator has reported a very large series of cases. Montgomery⁶ states that he has seen only 10 cases at the Mayo Clinic. Consequently the group of 8 cases studied in the Barnard Clinic was thought to be of sufficient interest to report.

As Montgomery⁷ has pointed out, the term Bowen's disease has been used loosely and incorrectly to include many conditions, especially those in which lesions occur on the mucous membranes and in which clinically as well as pathologically the picture is that of superficial squamous cell epithelioma in situ or even ordinary invading squamous cell epithelioma. The correct usage of the term should include lesions which are either multiple reddened scaly plaques or papular crusting tumor like or papillomatous growths in the skin. These vary greatly in size and may occur on any part of the body; their development is quite slow.

The microscopic changes (Figs. 376-377) encountered are a rather marked proliferation and hypertrophy of the epidermis (acanthosis).

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with great variability in size, form and staining reaction of the cells of the malpighian layer. These cells contain nuclei which vary in size and shape from pyknotic nuclei to large clumped giant nuclei. There are many multinucleated epithelial giant cells which are designated as Bowen cells or basket cells. These clumped nuclei are thought to arise as a result of amitotic cell division. Mitotic figures are also numerous and often atypical. Intracellular edema is usually present in the epidermal cells, many of which appear vacuolated. Intracellular bridges are preserved. The basal cell layer is intact throughout. When the basement membrane is broken the lesion has become an invasive squamous cell carcinoma. Bowen's disease never gives rise to basal cell carcinoma. The granular layer is often distorted and may be absent in places. Hyperkeratosis together with areas of parakeratosis is a constant finding. These characteristic alterations are limited to the epidermis since the dermis shows little but chronic inflammatory changes.

Montgomery,⁸ is inclined to accept Bowen's disease as a definite entity if the term is limited to lesions which fulfil the clinical picture as described by Bowen and Darier and which microscopically show the phenomenon described by Bowen with an intact basal cell layer. Thus it is seen that neither the clinical or histopathologic picture of Bowen's disease is specific but the two taken together constitute the diagnosis.

REPORT OF CASES

In a period of a little more than 6 years extending from 1938 through 1943 and including 3 months of 1944, 8 microscopically proved cases of Bowen's disease have been seen in the Barnard Clinic. During this time 2449 cases of carcinoma of the skin (basal squamous and basosquamous cell carcinoma) have been examined microscopically. This figure does not include lesions of the lower lip, vulva, penis or anus. The figures here presented show that it is a rare lesion comprising only 0.3 per cent of all cases of carcinoma of the skin.

The following brief summaries of the cases in the Barnard series are presented:

CASE I—F. S. 74 year-old white man was seen in 1938 complaining of a lesion (Fig. 375) behind the ear extending down to the angle of the jaw with a slowly enlarging red sharply outlined slightly scaly eruption of 2 years' duration. Ointments were used without benefit. In 1938 the lesion was noted to have a large considerably spreading down into the neck and up over the cheek and ear. The specimen was taken for histologic examination at this time. During the next 10 months 1900 r units of roentgen rays filtered with 1.5 mm aluminum were given to the cheek and neck and 600 r to the ear. Temporary improvement resulted but the condition slowly became worse. The patient died on September 9, 1942 at the age of 88 years of carcinoma of the prostate with metastasis.

The section showed fairly marked parakeratosis. Most of the granular layer was absent. The epidermis was acanthotic and the cells of the stratum spinosum



Fig 375 (Case 1)—Bowen's disease. A crusted irregular lesion involving the neck, cheek, and ear. This case shows much more extensive involvement than any of the other cases.



Fig 376—Photomicrograph of Bowen's disease ($\times 125$) showing hyperkeratosis and acanthosis with vacuolization of the cells of the stratum spinosum. The basal cell layer is intact throughout.

were large and many were vacuolated. There were numerous multinucleated cells (Boeie or basket cell) in this layer some contained as many as six to eight clumped nuclei. Mitotic figures were frequently encountered some were normal others showed enlarged chromosomes and atypical spindle fibers. In spite of the swelling and vacuolization of the cells intercellular bridges were present. The basal layer was intact throughout. In the upper third of the dermis a marked cellular infiltration made up predominantly of lymphocytes.

CASE II—S W a 6 year-old white woman was seen on December 5 1938 complaining of an eruption on her left hip of 7 years duration. There had been very slow extension. The lesion was symptomatic except that it occasionally became sore from irritation of clothing. Deepening was present at times. Examination showed a 5 by 6 cm superficial grayish red lesion with some crusting in the center. Microscopic examination revealed the Bowenoid change (Fig 3 6). Six hundred roentgen units of roentgen rays were given three times at weekly intervals, using a 15 mm aluminum filter. The lesions cleared completely. On March 14 1944 when the patient was last seen only an atrophic telangiectatic rosetting residual could be observed.

CASE III—B S a 51 year-old white woman was seen May 17 1939 complaining of a lesion on the left calf of 10 years duration. Examination showed a markedly crusted and inflamed superficial plaque 3 by 4 cm in diameter located on the line over the head of the left fibula. A specimen taken for microscopic examination showed typical Bowenoid change. The remaining lesions were also crusted. The result of treatment was very slow; halving a dose of 1400 roentgen units of roentgen rays were given complete epithelialization required 8 months. When observed on March 14 1944 only a smooth scar could be noted.

CASE IV—E D a 59 year-old white man was seen March 31 1941 complaining of a lesion on his left hip of 8 years duration. Beginning as a red papule it had gradually enlarged; the lesion had grown more rapidly in the past year and had begun to discharge and to become crusted. Examination revealed a 4 cm crusted and pathologic on the left hip. The lesion was excised in toto and was pathologically healed when last reported March 15 1944. Microscopic examination of the specimen removed showed the typical changes of Bowen's disease.

CASE V—W P a 67 year-old white man was first seen on June 23 1941 complaining of a lesion on his left arm of 3 years duration. The lesion had begun as a very small pigmented patch which had slowly enlarged to 1 by 0.5 cm and had become scaly. On July 1 1941 the lesion was excised. Microscopic examination of the specimen showed Bowenoid changes. The excised area healed. Nucleated epithelial cells in the dermis were noted in most of the other cases. By March 10 1944 the residual benign recurrence of the typical lesion had been removed. The keratosis had developed over the blemish.

CASE VI—E K a 58 year-old white woman was seen on October 8 1941 complaining of multiple lesions. The lesions were excised and the histology showed that they were basaloid carcinomas in the form of the basaloid carcinoma from the back. A squamous cell carcinoma from the right hand and junction type nevus from the right arm. As a result of these lesions in 7 months diameter on the entire surface of the left arm was a few unknown duration. It has been previously unobserved by the patient. It appeared like a small eczema to the patient than like a senile keratosis. The histologic changes were those of Bowen's disease.

On re-examination on March 7 1944 all previous sites of lesions showed no evidence of activity. However on the back 5 mm below the craters basaloid

squamous cell carcinoma there was a 1.5-cm triangular red slightly elevated lesion, with considerable crusting over half the surface. Also there were two smaller crusted lesions near the left arm scar one 4 mm in diameter the other 1 mm. All were excised and all showed Bowenoid changes microscopically.

CASE VII—A. H., a 16-year-old white woman was seen April 7, 1943 for excision of an asymptomatic lesion on the medial aspect of the left leg of 3 years duration. A small red papule had very slowly enlarged to the present size of 3 cm. It was slightly thickened and covered with crusts which were easily lifted

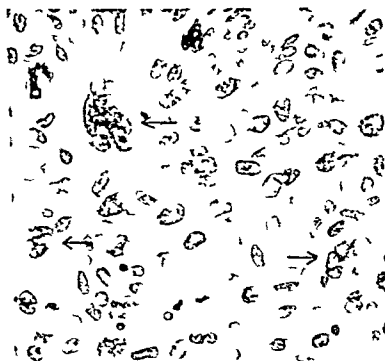


Fig 377—Photomicrograph of Bowen's disease ($\times 300$) showing (arrows) multi-nucleated epithelial giant cells or Bowen cells.

off leaving a red nonbleeding surface. Microscopic examination of the specimen removed confirmed the clinical diagnosis of Bowen's disease. In this case multi-nucleated epithelial cells (Bowen cells) were especially prominent (Fig 377).

CASE VIII—L. McE., a 41-year-old white man was seen March 7, 1944 complaining of an eruption on the left cheek of 2 years duration. The lesion had begun as a thin crusted area which gradually enlarged. Over the past year there had been considerably more crusting with the formation of several warty growths. One year previously the patient had been given five small roentgen ray treatments without benefit. Examination showed a 3 by 5 cm oval shaped patch of very slightly scaly erythema. Within the area were three papillomatous cone shaped projections with heavy crusting. Removal of the crusts revealed a raw oozing surface. The lesion was excised in toto. Microscopic examination showed the typical changes found in Bowen's disease.

ANALYSIS OF CASES

Sex, Race, and Age Incidence—The cases were divided equally between men and women. This is the usual finding as the sex of the

patient seems to play no role in this disease. All of the patients were white, but since only about 10 per cent of the Barnard Clinic patients are Negroes, no definite statement can be made from the present series regarding any racial factors in the disease. To our knowledge no case has been reported in a Negro. The age of the patients varied from 41 to 76 years, with an average age of 61 years, an incidence similar to that reported by other investigators.

Occupation, Family History, Personal History.—Although all the men in this series were engaged in occupations in which they had prolonged exposures to sunlight, none of the women were so employed. Notably only two of all the lesions were located on exposed parts of the body, and thus it would seem that exposure to sunlight or to any other occupational hazards is not an important factor.

A careful check on family histories revealed no evidence that the disease is familial.

In none of the cases was there a history of intake of arsenic.

Duration.—Bowen's disease develops slowly and is usually of long duration. Since the lesions are often asymptomatic, patients delay in seeking treatment. The duration of the lesions in the present series varied from 2 to 12 years. Only one case (Case VI) had multiple lesions.

DIFFERENTIAL DIAGNOSIS

To introduce differential diagnosis, a case is presented in which no definite diagnosis has been made. It will serve to raise some interesting questions which often present themselves when a case of Bowen's disease is under consideration.

CASE IX. R. P., a 58-year-old white man (Fig. 378), was referred to the Barnard Hospital in March 1939. He complained of an eruption on the temple of 5 years' duration which previously had been diagnosed as an epithelioma. The lesion had begun on the left temple as a small light brown slightly crusted, thickened patch which had gradually enlarged to a 6 by 8 cm area. A portion of the anterior section of the affected area showed a more marked crusted nodular thickening. The border was quite irregular and showed some undulating, but it could not be described as gyrate or rolled.

The patient gave a history of having had a papule here in 1912 treated at Hot Springs, Arkansas, which merely rubbed and bled for 1 month. In 1933 he again had a papule ruptured, which was given arsenopharm and bismuth. Weekly courses for 5 months. The patient's blood serum (Kahle) on February 21, 1939, was strongly positive.

A microscopic section of the lesion on the temple showed epidermal changes of a dyskeratotic type. The lesion was considered malignant, potentially so, and 750 r units of roentgen rays filtered with 15 nm of aluminum were given in two doses on successive days. The patient received antisyphilitic treatment in the form of mercurochrome by mouth and locally intramuscular injections of bismuth subacetylate. When he returned for observation in 5 weeks the temple lesion had almost completely healed. On March 10, 1944, the patient reported that the lesion had remained entirely well.

Bowen's Disease—In favor of the diagnosis of Bowen's disease are first, the clinical appearance and course. The eruption began as a slightly thickened light brown asymptomatic patch which became somewhat crusted and nodular and which slowly enlarged over a 5 year period. Secondly, the histologic changes were compatible with Bowen's disease in that evidences of retarded keratinization were present. The cells were irregular in size and shape and some showed vacuolization; many mitotic figures were present. However, no multinucleated epithelial giant cells could be found.

Epithelioma—The initial impression that the lesion was an epithelioma was thoroughly justified. The clinical appearance and course of



Fig 378—The sharply outlined thickened, crusted, slightly nodular eruption is compatible with the diagnosis of Bowen's disease.

a slow-growing basal cell carcinoma either of the ordinary type or of the type described by Montgomery¹ as being of multiple origin, may fit this description. These lesions are probably the ones most often confused with Bowen's disease in its early stages before nodulations develop. Superficial basal cell epitheliomas may become quite extensive and show a crusting erythema similar to that found in Bowen's disease but, in contrast, they frequently show a fine rolled, pearly border. Microscopically, the basal cell carcinomas are easily distinguished (Fig 379).

The superficial squamous or basosquamous cell lesions may have the same clinical appearance but they usually grow more rapidly. Microscopically, these lesions are not often confused with those of Bowen's

disease but it should be noted here that Bowen's disease is a squamous cell carcinoma in situ or an intraepidermal carcinoma and may occasionally show epithelial pearls similar to those found in ordinary squamous cell carcinoma.

Syphilis—Bowen's first case was long considered to be a syphilitic lesion before its true nature was recognized. Syphilis could account for the clinical appearance and course of the lesion in this case. However, the microscopic picture showed principally epidermal changes and only a nonspecific lymphocytic infiltrate in the dermis. The blood vessels showed no endothelial thickening and there was no perivascular cellular infiltration. Plasma cells in the dermis were not increased in numbers. The lesion was treated with roentgen rays but at the same time the patient was given enough antisyphilitic therapy to cause regression of the lesion had it been specific.

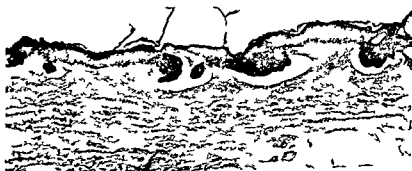


Fig 39—Photomicrograph of superficial basal cell carcinoma of multicentric origin ($\times 40$). Clinically this lesion often simulates the picture of Bowen's disease.

Arsenical Keratosis—On both gross and microscopic appearances the lesion could have been an arsenical keratosis. It is a well established observation^{13, 14} that arsenic in its various forms such as Fowler's solution, industrial contaminants and insecticides may cause potentially malignant keratotic lesions. These may occur anywhere in the skin but are more often found on the palms and soles. Our patient is known to have had arsenic in the bound organic form arsphenamine. Hueper¹⁵ reports that some cases are known in which this form of arsenic caused keratoses but these cases are extremely rare. Montgomery¹⁶ states that microscopically the picture of Bowen's disease and arsenical keratosis are essentially similar except that the latter shows more vacuolization of the epidermal cells and no multinucleated giant epithelial cells. Histologic examination of the lesion in this patient showed such a picture. However, this man had no other lesions and has developed none during the subsequent course of his antisyphilitic treatment in which arsphenamine was used. He has also received some relatively free arsenic which is always present as a contaminant in bismuth sub-

salicylate. The only way to have proved the lesion to be of arsenical origin would have been to find an appreciably higher percentage of arsenic in the lesion than in adjacent normal skin. This was not done.

Senile Keratosis.—It is conceivable that the lesion could clinically represent a senile keratosis. However, its surface showed a soft crusting in contrast with the harsh, tough, adherent scaling usually present in the keratotic lesion. Although keratoses may become as large as the lesion under discussion, they usually are much smaller. Microscopically, the senile keratosis may show all forms of dyskeratosis, some indistinguishable from that present in Bowen's disease. But most keratotic lesions which become malignant do so without showing much evidence of dyskeratosis.



Fig. 380.—Photomicrograph of Paget's disease of the breast ($\times 100$). Note similarity to the picture of Bowen's disease.

Seborrheic Keratosis.—The seborrheic keratosis often becomes as large as the lesion noted in this case, but the surface is usually oily, friable, and nevroid. When they occur on the face, the surface is sometimes drier and firmer than otherwise. However, the microscopic picture shows no dyskeratosis of any type.

Inflammatory Skin Diseases.—The chronic variable lesions of seborrheic dermatitis and psoriasis and the chronic persistent lesions of lupus erythematosus and lupus vulgaris may clinically simulate Bowen's disease, but histologically they show no dyskeratosis.

Paget's Disease.—In the case under discussion, Paget's disease of the skin would not be considered in the differential diagnosis, however

the clinical appearance of the lesion in Paget's disease of the nipple is sometimes indistinguishable from the lesion of Bowen's disease. Microscopically the changes in the two diseases may appear on superficial inspection to be quite similar. The section of Paget's disease (Fig 380) will usually show more large vacuolated cells which characteristically have lost their intercellular bridges. In Bowen's disease the intercellular bridges are present. Paget's disease does not show the epithelial giant cells with clumped nuclei found in Bowen's disease.

Paget's disease is sometimes considered to be an intra-epidermal invasion of malignant cells from an extra epidermal carcinoma probably by direct extension. A liberal interpretation of these criteria would not only account for Paget's disease of the nipple but for other extramammary lesions which resemble Paget's disease such as a rectal carcinoma at the anus invading the skin of the buttocks.¹⁶ This type of case is exceedingly rare and would necessarily be an association of skin change with an underlying carcinoma.

The existence of true extramammary Paget's disease in the sense that the Paget's picture with pagetoid cells develops as an intra-epidermal carcinoma per se is very doubtful. Most cases so diagnosed are probably examples of Bowen's disease.

Summary of Differential Diagnosis—In summary superficial epithelioma, syphilis, seborrheic keratosis, seborrheic dermatitis, psoriasis, lupus erythematosus and lupus vulgaris are eliminated by study of the microscopic sections. Extramammary Paget's disease is a doubtful entity and is not considered. We cannot with certainty rule out an arsenical keratosis since the patient had been subjected to large doses of arsenic but in the bound organic form. In addition we cannot definitely say that this lesion is not senile keratosis although we feel that the clinical appearance is against this diagnosis. We feel that this lesion is probably one of Bowen's disease.

TREATMENT

In the consideration of treatment the fact that Bowen's disease is an intra epidermal carcinoma must be kept in mind. The lesion may change to actual invasive squamous cell carcinoma with possibilities of metastases. The treatment should be total excision by whichever method is most applicable to the individual case, either scalpel excision, actual cautery or surgical diathermy. A few workers recommend x-radiation; however Ormsby and Montgomery⁸ consider it contraindicated on the grounds that the histopathologic picture in Bowen's disease closely resembles that seen in chronic radiodermatitis.

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MYCOTIC GRANULOMAS SIMULATING MALIGNANT DISEASE

MORRIS MOORE PH D *

NUMEROUS workers have emphasized that fungous infections particularly the mycotic granulomas may simulate various clinical entities notably malignant neoplasms. The reaction to these particular infections leads to the formation of a tumor—a granuloma. Pathologically there is a fundamental difference between such a granuloma and a true neoplasm. However the picture in many of these mycoses histologically may so simulate benign or malignant neoplasms that in the hands of one not familiar with the behavior of fungi a mistaken diagnosis of malignant disease could easily be made. Clinically too the course of these mycotic granulomas may be not unlike that of a neoplasm whether it be cutaneous or systemic benign or malignant.

In general fungous infections attack male and female alike of all ages. The granulomatous lesions however seem to be present for the most part in adults of the middle age group. This is an important fact, since it is also the so called cancer age group. Certainly such a point is worthy of consideration especially when we realize that a carcinoma may be mistakenly diagnosed as a fungous infection as has been done on repeated occasions. The tremendous import of such a mistaken diagnosis can be brought home when we consider the difference in treatment in the two especially the type and urgency of such treatment in the case of malignant neoplasms.

The clinical diagnosis of mycotic granulomas is not often easy. The finding of the causative fungus the deciding factor in correct diagnosis is not always simple in direct examination of scrapings exudate or sputum even in the hands of trained workers. Consequently the determination of the disease has usually rested on the skill of the pathologist.

Mycotic granulomas fortunately are not as prevalent in number as are the fungous infections known as dermatomycoses. They are however widely distributed over the world some being endemic in certain areas.¹ In general these diseases arise as a result of a traumatic infection except for those mycoses which develop systemically through the inhalation of air borne spores. Diagnosis of the latter has rested chiefly in the hands of roentgenologists. In most cases however the correct diagnosis was not established until either secondary cutaneous lesions developed or infected tissues were studied postmortem.

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The fungous infections described as granulomatous and which may of en be confused with neoplastic disease consist of sporotrichosis actinomycosis maduromycosis chromomycosis cryptococcosis paracoccidioidal granuloma coccidioidal granuloma histoplasmosis aspergillosis and mucormycosis *

SPOROTRICHOSIS

Definition—Sporotrichosis is a granulomatous disease process which manifests a multiplicity of clinical forms and is usually confined to the cutaneous or subcutaneous structures spreading through the lymph channels or it may involve the internal viscera bony structures and the cerebrospinal system The infection is subacute or chronic and is caused by members of the genus *Sporotrichum*

Clinical Manifestations—The clinical course of sporotrichosis is much like that of other mycotic granulomas The disease manifests itself in various forms affecting the skin cutis and subcutis and may also spread systemically For purposes of general classification sporotrichosis has been separated into three clinical groups each made up of various types

I Localized Sporotrichosis Cutaneous or Subcutaneous—1 Gummatous lymphangitis with or without an initial sporotrichotic chancre and adenitis 2 Inoculation chancre and adenitis without lymphangitic involvement and without gummatous formation 3 Primary sporotrichotic chancre without lymphangitic involvement 4 Gummatous lymphangitis without the chancre 5 Gummatous sporotrichosis in steps localized to one area without chancre and without lymphangitic involvement

II Gummatous Disseminated Sporotrichosis—1 Nonulcerating gummatous forms 2 Ulcerating disseminated subcutaneous sporotrichosis including the tuberculoid syphilitic ulcerating polymorphic and furuncle like types 3 Large multiple disseminated abscesses 4 Mixed forms including polymorphic gummas large abscesses secondary lymphangitis dermic and epidermic lesions and associated involvement of the mucous membranes and internal viscera and organs

III Extracutaneous Forms or Systemic Sporotrichosis—This group includes involvement of the mucous membranes lungs muscles osseous structures joints synovial membranes and other internal viscera and organs These may be and usually are associated with primary or secondary cutaneous lesions

Diagnosis and Differential Diagnosis—The diagnosis of sporotrichosis is relatively easy in the lymphangitic type since the clinical features may be pathognomonic The chain of nodules follow along the lymph channel and originate from a primary focus on a finger the hand or wrist following a trauma Squamous cell carcinoma may spread by way of the lymph channel and present a similar picture This was seen recently in the clinic on two separate occasions when the patients both men had nodular lesions extending up the arm following the lymph channels In both cases the clinical impression was sporotri

For more detailed information the reader is referred to Section VIII Diseases Caused by Yeasts and Fungi by Morris Moore in Clinical Tropical Medicine edited by Z. Taylor Bercovitz, pp 694-739 New York Paul B Hoeber Inc 1944

chosis Fortunately biopsies were made before treatment was instituted and the diagnosis of squamous cell carcinoma was established by the pathologist In localized lesions which may become ulcerative or nodular and gummatous a neoplasm must definitely be ruled out, as well as syphilis and tuberculosis (Fig 381) The disease when generalized may also present a picture not unlike neoplastic disease



Fig 381—Sporotrichotic ulcer with indurated edges resembling clinically squamous cell carcinoma

To determine the diagnosis the causative fungus should be cultivated from an unruptured nodule Smears in sporotrichosis are of little value since it is difficult to demonstrate the organism in slide preparations In tissue Unna's polychrome methylene blue may be used to demonstrate *Sporotrichum* Complement fixation tests may be used diagnostically as well as sporotrichin the fungous extract but these are not always reliable

ACTINOMYCOSIS

Definition—Actinomycosis is a local or spreading disease which is granulomatous in nature and may be acute subacute or chronic It is characterized chiefly by sinuses and fistulas from which may be isolated variously colored granules which are growths of species of the genus *Actinomyces*

Clinical Manifestations—Clinically actinomycosis can be divided into two main groups the cutaneous and visceral types

The cutaneous type may be either *primary* occurring in the epidermic layer as a nodule which extends into the corium and the subcutaneous layers or *secondary* to a deep seated infection which usually occurs in the tissue closely associated with the buccal thoracic or abdominal cavities and pushes its way to the superficial layers of the skin

In primary actinomycosis of the skin the nodule penetrates the deeper layers of the skin enlarges softens at the surface becomes fluctuant and finally ruptures exuding a seropurulent or sanguineous material containing the so called *sulfur granules*. The nodule finally becomes an ulcer and eventually becomes scarred or forms a crust, which does not allow the lesion to heal rapidly. Quite often new nodules form in the vicinity of the first nodule these going through the same type of evolution. Such a mass of ulcerated nodules may simulate closely a carcinoma. The lesions change in color from pink to a dusky red.

Cutaneous lesions secondary to a subcutaneous involvement manifest themselves clinically as subcutaneous nodules or tumors which are rather firm in nature and livid in hue. These increase in size soften fluctuate and break down to give off also a seropurulent discharge containing the granules. As a result of the breaking down of these lesions fistulas are produced which become intercommunicating and through which the *Actinomyces* are distributed setting up new foci of infection in the form of nodules. The surrounding skin then becomes a mass of granulomatous material with an oozing discharge. The picture becomes very confusing and simulates at times a carcinomatous overgrowth.

Subcutaneous nodules that show no sinuses located in the neck region should be given careful consideration. The following is a typical case history illustrating a diagnostic pitfall.

A white man aged 29 years seen in our surgical service complained of a mass of 3 months duration. The growth was situated in the left submaxillary region. The lesion was diagnosed clinically as a mixed tumor of the submaxillary gland. There was no sinus discharge or drainage. The mass was completely removed surgically and found to be actinomycosis. The man was inducted into the United States Army. While in New Guinea several months later a sinus developed in the adjacent region the chin. The diagnosis of actinomycosis was confirmed by an Army medical officer.

In its visceral manifestations actinomycosis usually shows a series of anatomical involvements beginning with the tongue extending to the tonsils pulmonary system intestinal tract urinary tract cerebrospinal system and the osseous structures. The destructive process involved here is essentially similar to that seen in the skin. Usually the fungus bores through the adjacent subcutaneous layers to the surface of the skin the secondary cutaneous type developing intercommunicating sinuses.

Pulmonary actinomycosis may be one of four types the *bronchitic*, the *pneumonic*, the *pleuropneumonic* and the fourth or *metastatic* type where nodules have formed in various parts of the lungs as a result of the hematogenous spread of the fungus. This may mimic confusingly a metastatic pulmonary carcinoma.

Diagnosis and Differential Diagnosis—The finding of the granules or masses of filaments and spores of the fungus *Actinomyces* in the discharge or in the sinuses is usually the best assurance of a correct diagnosis. Usually the lesions are diagnostic *per se*. One must always be on guard against just such confusion with carcinoma as has been related above. Tuberculosis and syphilis should be considered. Agglutination tests and cutaneous reactions with the vaccine actinomycin may be used diagnostically.

MADUROMYCOSIS

Maduromycosis

Definition—Maduromycosis is a chronic granulomatous process localized usually to the extremities but occasionally affecting other parts of the body. It is characterized by variously sized enlargements on the cutaneous surface which eventually give rise to intercommunicating sinuses and fistulas from which variously colored granules comprising fungous elements of the genera *Actinomyces*, *Madurella*, *Morospodium*, *Allescheria*, *Indiella*, *Trichosporium*, *Aleurisma*, *Aspergillus*, *Penicillium* and *Sterigmatocystis* can be obtained.

Clinical Manifestations—Maduromycosis gives rise to lesions which develop mycetomas as the result of a trauma either on the extremities, cervicofacial or cephalic, thoracic and abdominal regions. The infections may manifest themselves first as localized tenderness, pain with slight swelling or their symptoms may be altered in part. Four types or perhaps stages have been described: a papule, a deep seated and fixed nodule, a swollen area which becomes hard and develops a vesicle and finally an abscess. Usually, however, the initial lesion is deep seated and increases in size with new lesions appearing as satellites. As a result there is developed an edema, more or less granulomatous in nature which takes on the characteristics of a tumor. The whole mass increases in size and then begins to soften, fluctuate, with the primary more superficial lesions rupturing and forming sinuses which discharge a characteristic oily, seropurulent, blood streaked, viscid fluid within which are found the typical black, yellow, white or red granules.

Diagnosis and Differential Diagnosis—The differentiation of mycetoma from tumors of the skin rests almost entirely on the microscopic examination of the exudate and of the tissue in an effort to find the granules or fungous accumulations. The subsequent cultivation and identification of the fungus involved establishes the correct diagnosis.

CHROMOMYCOSIS

Chromoblastomycosis Dermatitis Verrucosa Cutis

Definition—Chromomycosis is a chronic granulomatous disease involving usually the extremities but may affect other parts of the cutaneous surface as well. The lesions may be papular nodular verrucous or granulomatous with or without ulceration and abscess formation. Systemic invasion has not been reported and the lymph nodes are rarely found. Pain or pruritus is rare. Thick walled, brown multilocular cells of various genera *Phialophora* *Hormodendrum* (*Fonsecaea*) *Hormodendroides* *Botrytoides* and *Phialoconidiophora* are found in the tissues or exudate.

Clinical Manifestations—Chromomycosis is seldom recognized clinically except in regions where the disease flourishes and where it presents characteristic lesions. Like other mycotic granulomas the disease may simulate carcinoma, among others.

Generally considered to be the result of a traumatic infection with contaminated products of the soil, chromomycosis has for the greater part produced lesions on the extremities, hands and feet. Reports in the literature however indicate that other parts of the cutaneous surface may be affected. These include the wrist, arm, shoulder, neck, face, ear, chest, abdominal region, buttock, thigh, knee and leg. The larger number of patients were farmers, workers of the soil or its products.^{3, 4}

Clinically, chromomycosis presents lesions which may be papular, verrucous or papillomatous, nodular, ulcerative, psoriasiform, granulomatous with or without abscess formation and with rarely any suppuration except when due to secondary infection with bacteria. Scaliness is usually present. Pain or pruritus rarely occurs. Systemic invasion is not a feature and bone involvement has not been reported. Lymphangitis and regional adenopathy when present are usually attributed to secondary infection. As the disease progresses and persists the lesions show cicatrization. On the extremities the progressive formation of additional lesions accompanied by tissue reaction may result in elephantiasis.

Small ulcers of chromomycosis may bear a striking resemblance to cutaneous cancer. This is well exemplified in the following case.

A white man, aged 38, a farmer, presented himself in May, 1941, at the Barnard Free Skin and Cancer Hospital complaining of a "sore" on the right ear. He was admitted to the surgical clinic by the admitting officer. His family and past history were noncontributory. His systemic review revealed normal findings. Two months previously he noticed an eruption on the helix of the ear. This had slowly increased in size.

On examination, there was found, just inside the helix of the right ear, a slightly raised ulcerative area measuring 1.5 by 0.6 cm. There were no palpable nodes in the neck. The clinical diagnosis was squamous cell carcinoma. An excision of the entire lesion and part of the cartilage was recommended. In June, 1941, a cautery excision of the lesion, including a segment of the cartilage, was

made. A microscopic examination of a section of the tissue revealed the characteristic organisms and a diagnosis of chromomycosis was made.

On the basis of clinical studies chromomycosis may be divided into five groups (1) The *verrucous* or *papillomatous* type which may appear not unlike carcinoma (2) The *tuberculoid* type (3) The *typhlioid* form which when presenting ulceration with a hypertrophic base due to granulation tissue may resemble carcinoma (4) The *psoriasiform* type (5) This group comprises those lesions which become cicatrized and those which result in elephantiasis of the extremity. Verrucosities, abscesses, ulceration and scaling may be present.

Diagnosis and Differential Diagnosis—The diagnosis of chromomycosis rests entirely upon finding in tissue or pus the dark brown thick walled spherical or irregular in outline single multiple or multilocular sclerotic cells measuring 3 to 10 microns in diameter. Both histologically and clinically chromomycosis may so resemble squamous cell carcinoma that careful search for organisms must be instituted by the pathologist.

BLASTOMYCOSIS

Definition—The term blastomycosis in its medical interpretation represents a clinical syndrome with a multiplicity of causative agents. In its wider application or as used by medical men in general this term includes all those diseases which are produced by budding yeastlike organisms. The disease is protean in its manifestations and represents a group of closely allied multiform clinical conditions. No organ or tissue is immune the disorder involving the cutis as well as the internal viscera and bony structures in its systemic spread. The disease process varies somewhat in the various continents with different causative agents. In North America the disease is termed Gilchrist's disease or North American blastomycosis and is caused by a double contoured simple or budding yeastlike cell called *Zygomema* (*Blastomyces*) *dermatitidis*.⁵

GILCHRIST'S DISEASE OR NORTH AMERICAN BLASTOMYCOSIS

Clinical Manifestations—Clinically blastomycosis shows lesions which are alike both for the cutaneous type of the disease or for the systemic type of the disorder with foci in the lungs, bones, meninges, liver and other structures. The cutaneous type may be further separated into that which is *primary* in character as occurring in the epidermic layers and *secondary* when it is due to an infection of the deeper tissues, internal viscera and bony structures.

The primary form or cutis infection may present one of three varied appearances: papulo-ulcerative, verrucous or papillomatous and gummatous.

The *papulo-ulcerative* type shows initial lesions which are papulopustular in character and of epidermic origin.

The *verrucous* or *papillomatous* type is nodular or papular in char-



Fig 382—Blastomycotic ulcer clinically and pathologically resembling squamous cell carcinoma (as incorrectly diagnosed by clinician and pathologist)



Fig 383—Blastomycosis confusingly resembling carcinoma

acter and present on a normal or deep red infiltrated skin. Several of the lesions may coalesce to form papillomatous patches which resemble verrucous tuberculosis or carcinoma (Figs 382 and 383)

The histopathology of verrucous cutaneous blastomycosis in the apparent absence of organisms is so similar to squamous cell carcinoma that the pathologist may unknowingly and not infrequently make an incorrect diagnosis. This has happened on several occasions at the Barnard Free Skin and Cancer Hospital. Fortunately, however, the correct diagnosis was finally established either by culture or by finding the characteristic fungi in the tissue after careful search before radical treatment was instituted.

The *gummatous* type develops from the subcutaneous layers of the tissue of the deeper portion of the cutis. This type may closely resemble squamous cell carcinoma.

The *secondary* cutaneous form consists chiefly of variously formed ulcers which give off a purulent or sanguinopurulent discharge from a soft granulating floor.

The ulcers originate in abscesses which clinically may be divided into the *superficial* and *deep* types. Superficial ulcers arise usually in the subcutaneous tissues as nodules of varying size. The deep type shows fewer lesions which are deep seated. These are more serious than the superficial type since they involve destructive processes of the bone, muscle and deep tissues and organs.

The disease being protean in character every organ in the body is subject to it. The skin and its appendages have shown the greatest incidence of infection. Many skin lesions are manifestations of spread from some internal organ. The pulmonary system including bronchi and lungs are next in incidence being followed by the kidneys, spleen, bones and joints, liver, pleura, lymph nodes, cerebrospinal system, vertebrae, prostate, heart, pancreas, peritoneum, eyes, larynx and trachea, gastro-intestinal tract and the tongue.

Diagnosis and Differential Diagnosis—In its cutaneous manifestations, blastomycosis should be differentiated from neoplasms, tuberculosis, verrucosa cutis, syphilis and bromide eruptions and other mycotic granulomata. The use of the fungous extract *blastomycetin* has been recommended for diagnostic purposes. It is always best, however, to demonstrate the fungus in tissue, pus, exudate or sputum. The actual cultivation of the fungus is not difficult and should be made when possible.

EUROPEAN BLASTOMYCOSIS

Cypt c T I B B H D

European blastomycosis is closely related to Gilchrist's disease. The fungus responsible for the disease is a budding yeastlike organism 5 to 10 microns in diameter which in tissue produces a thick, mucoid, refractile capsule. The organism is called *Cryptococcus hominis* also referred to as *C. histolyticus*.

Clinical Manifestations—This disease may be divided into the *cutane*

ous and *systemic* types The ulcerative type of lesion is predominant in the cutaneous form which microscopically shows abscesses with few leukocytes and little inflammation (Fig 384) A granulomatous response may also be seen in the cutaneous lesion The abscesses are actually areas of hyalinization made up of masses of fungi with thick clear capsules⁶

In North and South America this disease is present under the name of torulosis as well as cryptococcosis Although the organism is apparently the same it seems to show a greater affinity for the cerebrospinal system primarily with the pulmonary system either primarily or sec



Fig 384—Cryptococcic (torulosis) ulcer resembling squamous cell carcinoma Cutaneous metastatic ulcer primary focus in brain and diagnosed incorrectly brain tumor (Case of Mook and Moore 1936)

ondarily affected Primary pulmonary cryptococcosis shows small nodules or tubercles miliary in nature which roentgenologically could be diagnosed as miliary tuberculosis or primary carcinoma with satellite metastases

Diagnosis and Differential Diagnosis—The organism of cryptococcus like that of Gilchrist's disease must be found either in tissue sputum spinal fluid or in skin scrapings to establish a diagnosis The disease should be differentiated from carcinoma and tuberculosis of the lungs Lesions of the brain in particular should be differentiated from brain tumors and in cryptococcosis of the spinal cord tumors should likewise be ruled out

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The disease being protean in character every organ in the body is subject to it. The skin and its appendages have shown the greatest incidence of infection. Many skin lesions are manifestations of spread from some internal organ. The pulmonary system including bronchi and lungs are next in incidence being followed by the kidneys, spleen, bones and joints, liver, pleura, lymph nodes, cerebrospinal system, vertebrae, prostate, heart, pancreas, peritoneum, eyes, larynx and trachea, gastro intestinal tract and the tongue.

Diagnosis and Differential Diagnosis.—In its cutaneous manifestations blastomycosis should be differentiated from neoplasms, tuberculosis, verrucosa cutis, syphilis and bromide eruptions and other mycotic granulomata. The use of the fungous extract *blastomycetin* has been recommended for diagnostic purposes. It is always best however to demonstrate the fungus in tissue, pus, exudate or sputum. The actual cultivation of the fungus is not difficult and should be made when possible.

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Fig 384—Cryptococcic (torulosis) ulcer resembling squamous cell carcinoma. Cutaneous metastatic ulcer, primary focus in brain and diagnosed incorrectly as brain tumor (Case of Mook and Moore 1936).

ondarily affected. Primary pulmonary cryptococcosis shows small nodules or tubercles miliary in nature which roentgenologically could be diagnosed as miliary tuberculosis or primary carcinoma with satellite metastases.

Diagnosis and Differential Diagnosis—The organism of cryptococcosis is like that of Gilchrist's disease must be found either in tissue, sputum, spinal fluid or in skin scrapings to establish a diagnosis. The disease should be differentiated from carcinoma and tuberculosis of the lungs. Lesions of the brain in particular should be differentiated from brain tumors and in cryptococcosis of the spinal cord tumors should likewise be ruled out.

SOUTH AMERICAN BLASTOMYCOSIS

P c id d I G I m L t z Spl d d Alm d D

Paracoccidioidal granuloma like North American blastomycosis manifests a multiplicity of clinical forms and is caused by several members of the genus *Paracoccidioides* (*P. brasiliensis*, *P. tenuis* and *P. cerebriformis*)⁵

In tissue or pus *P. brasiliensis* and *P. tenuis* consist of spherical or ovoid cells 1 to 30 microns in diameter rarely larger with thick walls. These mother cells show simple or multiple budding of minute spherical ovoid or bacillary gemmules approximately 1 micron or larger in



Fig. 385—Paracoccidioidal granuloma lymphatic type simulating malignant of the parotid (Case of Dr. de Aguiar, Porto 1937)

diameter *Paracoccidioides cerebriformis* shows somewhat larger cells and buds. These cells are often seen in giant macrophages (pseudococcidioides).

Clinical Manifestations—Clinically paracoccidioidal granuloma may be divided into the *localized*, *buccal mucosa* type due to *P. cerebriformis* and the *generalized* type due to *P. brasiliensis* and *P. tenuis*. The generalized disease may be acute or chronic. The fungus may enter the buccal cavity lodging usually in the gums and forming a hard infiltration which spreads to the lips, the nose and the margin of the tongue. This presents a histologic picture of granuloma. A pseudotuberculous papule may be produced on the uvula and a papillomatous vegetation may develop on the tonsils and the gingiva giving the ap

pearance of an acuminate condyloma. The ulcerative processes may spread to the skin presenting likewise vegetative and papillomatous lesions on the body simulating squamous cell carcinoma. In generalized infections of the skin *cutaneous type*, the primary lesions may have developed as the result of an abrasion or wound where the fungus has become lodged with subsequent pathologic change.

The lesions of many cases of chronic paracoccidioidal granuloma may remain localized in the mouth. The invading germ, however, may penetrate into the tonsils causing the disease to become systemic by means of the lymph stream, to produce the *lymphatic type* (Fig 385) affecting the nodes in the neck, supraclavicle and axillae, often



Fig. 386.—Paracoccidioidal granuloma, cutaneous type resembling squamous cell carcinoma. (Sao Paulo, Brazil.)

simulating Hodgkin's disease and lymphosarcoma, and the *visceral type* affecting the internal viscera and organs much like a metastatic carcinoma. Where *P. cerebriformis* is the causative agent, this usually happens in the terminal stages of the disease. Where *P. brasiliensis* or *P. tenuis* is concerned the tonsils may be attacked *a priori* producing thus acute ulceration and inflammation, with a localized lymphangitis, which soon becomes generalized. There is developed then a typical granulomatous condition of acute blastomycosis.

A fourth clinical type may be considered as the *mixed type* involving the systemic spread and the cutaneous lesions which manifest themselves in the following various appearances: (1) *papular*, showing superficial lesions, lenticular papules with a slow evolution and a

tendency to form superficial ulceration and epidermic microabscesses (2) *papulopustular* localized in follicles (3) *tuberosus* made up of small nodules which infiltrate the dermis (4) *ecthymiform ulceratum*, lesions (5) *vegetating types* papillomatous exudative lesions covered with a serous or seropurulent crust resembling carcinomatous processes (Fig 386) (6) *hypodermic granuloma* nodular in type forming subcutaneous abscesses with secondary ulceration (7) *scrofuloderma* showing cutaneous abscesses and fistulae. In addition the lesions of the mouth and lips give rise to (8) *mulberry type of ulcerous stomatitis* in which the lesions are localized in the buccopharyngeal mucosa take on the form of a mulberry beginning at the edge of the gums and extending to the floor of the mouth and involving the various anatomical regions and may often be mistaken for carcinoma (9) *hyper trophic diffuse granuloma of the lips* showing a tendency to ulcerate with the same mulberry like formation.

Diagnosis and Differential Diagnosis—The finding of the characteristic multiple budding organisms in tissue or pus is usually sufficient to establish a diagnosis. Fortunately this disease is not present at least up to the present time in North America. The return of members of the armed forces from South American countries where the disease is prevalent makes it worth while to keep it in mind. It is very important to differentiate this disease from squamous cell carcinoma lymphosarcoma Hodgkin's disease syphilis and tuberculosis.

COCCIDIOIDAL GRANULOMA

Definition—Coccidioidal granuloma as a disease belongs to the class of infectious granulomas and is caused by *Coccidioides immitis*. It is endemic in certain parts of the United States (San Joaquin Valley California Arizona) and South America. It may be exceedingly acute and disappear in a short time usually a few weeks (coccidioidomycosis) or end fatally or it may be chronic and painful extending over several years. On the other hand it may be long drawn out and attended with little pain. There is a third or subacute type which is neither rapidly fatal nor unduly prolonged but which is characterized by a definite and positive tendency to widespread dissemination. With this form there are usually associated remissions and relapses the sufferer living from 6 months to 2 years without evidence of infection.

Clinical Manifestations—The early acute form of this disease coccidioidomycosis commonly called valley fever or desert fever affects persons of all ages and of both sexes. The patient is usually ill from 3 to 6 weeks and in most cases recovers without having any complications. At the onset of the acute illness the patient complains of a bad cold or flu with headaches general aches and pains occasionally severe about the chest resembling pleurisy. There may be gastro intestinal disturbances a mild sore throat usually diagnosed as tonsillitis and some conjunctivitis with bulbar hyperemia. There is

rapid loss of weight and a fever beginning on the fourth or fifth day. There may be chills and sweating and signs of severe bronchitis and bronchopneumonia with an accompanying cough with a mucopurulent sputum. Organisms may be found in the sputum. The patient may feel better after a few days but between the eighth and fifteenth day after the onset erythematous nodules called the bumps may develop on the shins thighs buttocks arms upper part of the chest or scalp. These are typical lesions of erythema nodosum. When they occur on parts of the body other than the shins these lesions have been termed erythema multiforme. These nodules do not fluctuate or suppurate but may be fiery red and tender and painful. Within 48 to 72 hours the nodules change to a purplish color and then fade to a brown within 4 or 5 days and persist for several weeks.

When the disease persists however it goes on to produce the characteristic signs and symptoms of coccidioidal granuloma. Clinically coccidioidal granuloma manifests itself as a localized or systemic disease granulomatous in nature and protean in character often simulating neoplasms. There are several types of this phase of the disease. The lesions may be primarily cutaneous with later generalization primarily pulmonary with or without secondary cutaneous manifestation and usually generalization primarily pelvic meningeal or spinal cord or joint involvement with no skin lesions and primarily involving the bone or subcutaneous tissue with secondary skin lesions.

The fungus may enter the skin through an abrasion or wound. It may involve the lungs through the inhalation of spores as evidenced in a hot climate where it is dry. It is probable that such clinical types involving the meninges subcutis and joints in addition to the pulmonary and bone lesions are primarily lung infections. This is usually brought out in the autopsy reports.

The multiform clinical entities of the disease may simulate through a metastatic action of the fungus proliferating and suppurating processes especially in the verrucous like dermic lesions. The dermic lesions may be nodular and ulcerative in the form of painless deep seated pinkish or dusky red ulcers becoming necrotic and sluggish or they may develop papillomatous growths resembling epitheliomas or *verruca* tuberculosis in its various forms syphilis blastomycosis or even sporotrichosis. Subcutaneous involvement has three types of lesions the flaccid tumor the abscess and the gummatous varieties which may imitate cold abscesses or tumors as the names imply (Fig 387). Pulmonary infections resemble closely tuberculosis. Bone infections can hardly be differentiated from osseous tuberculosis osteomyelitis or arthritis. Involvement of the meninges and spinal cord simulate closely tuberculous meningitis epidemic meningitis and tumors of the spinal cord. Gastro intestinal disorders of coccidioidal granuloma usually run the typical course of typhoid and not until secondary cutaneous lesions develop is an accurate diagnosis usually made. Lymph node involve

ment usually suggests lymphatic leukemia Hodgkin's disease and lymphosarcoma

Diagnosis and Differential Diagnosis—The ability of coccidioidal uloma to simulate many well known processes makes it imperative to establish a correct diagnosis This can best be done by demonstrating the fungus either in tissue sections (biopsy) in pus or in sputum *Coccidioides immitis* may be found isolated or in giant cells as a



Fig 387—Coccidioidal granuloma resembling fibrosarcoma (Case of Jacobson)

ical thick walled structure with a reported diameter of approximately 2 to 80 microns The fungus reproduces by endospore formation and shows no budding In endemic areas it is often advisable to use a fungous extract coccidioidin for diagnostic purposes

In the acute stage of the disease pneumonias of various types should be ruled out In the granulomatous stage of the disease it is necessary to eliminate among other diseases squamous cell carcinoma other tumors leukemia Hodgkin's disease and lymphosarcoma

HISTOPLASMOSIS

D i g D R + I d t h l l Cyt my H + cyt

Definition—This is an acute or chronic invariably fatal fungous infection characterized usually by fever loss of weight or emaciation anemia leukopenia and splenomegaly with a marked invasion by reti-

ulo-endothelial histiocytes engulfing organisms of the genus *Histoplasma* (*H. capsulatum* and *H. pyriforme*)

Clinical Manifestations—Histoplasmosis is characterized by a number of clinical signs and symptoms depending on the organ or organs involved. Lesions may be localized to one anatomic region or they may be generalized to involve practically the entire system. Usually, however, the patient dies as a result of a generalized infection. The chief signs in such cases are anorexia with resultant emaciation which may be severe or moderate, asthenia, anemia occurring usually in the terminal stage, leukopenia which may be marked, irregular pyrexia, splenomegaly and in many cases hepatomegaly. There may be generalized pain in the back, joints, muscles or localized pain such as epigastric or lower abdominal. The latter may be accompanied by vomiting and diarrhea. Pain in the chest may occur along with a cough, hoarseness, sore throat and difficulty in breathing. Headaches have also been known to occur. The enlarged spleen may be lacking in some cases, however, postmortem findings in generalized cases invariably reveal the fungi in this organ. In a few cases the anemia, splenomegaly and leukopenia were lacking. There may be a systemic febrile condition with a septic temperature curve accompanied by an enlarged spleen and liver not unlike the characteristics of kala-azar. The superficial lymph nodes generally and the deep nodes occasionally become involved and enlarged, the former presenting a picture not unlike Hodgkin's disease, lymphosarcoma or leukemia.

Like other mycotic infections which tend to become systemic and present a granulomatous picture, histoplasmosis can be divided into several distinct types. It must be added, however, that although specific organs may be solely involved, the infection spreads rapidly and becomes more or less generalized systemically at the time of death. This has been shown to be true in most of the cases that have been examined postmortem. On the basis of location of lesions, therefore, histoplasmosis may be divided into two main groups: *cutaneous* and *systemic*.

A CUTANEOUS TYPE—Histoplasmosis of the skin may be primary or secondary in the form of nodules, papillomata, ulcers, suppurative processes and scaling. The cutaneous type is further subdivided into the *mucocutaneous*, *otic* and *naso-oral* types. The naso-oral type is of chief interest here.

The lesions of the naso-oral type are usually granulomatous but may be of various types involving practically all the structures of the oral and nasal cavities. On the tongue, gums and lips may be seen nodules, some of which appear like polyps simulating a carcinomatous process. The nodules usually ulcerate so that ulcers seem to predominate. A verrucous or vegetating mass may be found in the oral cavity. The buccal mucosa is most often involved, usually showing an ulcerous lesion which tends to spread, simulating a proliferating carcinoma.

A case of this disease from our recent records is that of a 61 year-old white man who complained of a sore in the roof of the mouth (Fig 388). The sore had begun two months previously and had gradually increased in size but was not painful or tender. A biopsy taken from the right upper alveolus was sent to the pathological laboratory with a clinical diagnosis of carcinoma of the buccal mucosa. *Histoplasma* was found in one small area of the biopsy specimen and the correct diagnosis established.

The following case perhaps establishes even more clearly the similarity of histoplasmosis to carcinoma. The patient was a 71 year-old white man who had



Fig 388



Fig 389

Fig 388—Ulcer of histoplasmosis on palate typically resembling squamous cell carcinoma and so diagnosed incorrectly in the clinic (Case of Moore and Jorstad 1943)

Fig 389—Ulcer of histoplasmosis of the tongue incorrectly diagnosed clinically as carcinoma of the tongue (Case of Dr Shelton)

an ulcer on the left side of the tongue (Fig 389). The lesion was of several months duration. The tongue was painful and the patient complained of shortness of breath, orthopnea and cough. On the assumption that the lesion was a carcinoma of the tongue radium (radon seeds) was implanted. The lesion regressed somewhat but was followed by a marked inflammatory response which interfered with the patient's ability to swallow food. The correct diagnosis was established following treatment but the disease became generalized and the patient died.

Involvement of the nasal structures is usually considered as part of the oral lesion. Ulcers of the nasal mucosa occur usually as extensions from the oral lesions. Granulomatous lesions of the nares may be seen which are not unlike small tumor-like growths. The growth may in

volve the nasal septum and cause it to be perforated with the development subsequently of a mucopurulent rhinitis

B SYSTEMIC HISTOPLASMOSIS—From the oral cavity the infection usually spreads to various parts of the body including the pulmonary system gastro intestinal tract genito urinary tract including kidney and prostate adrenal lymph nodes superficial and deep spleen liver pancreas pleura cerebrospinal system including brain and meninges heart thymus bone marrow and bone and joint

Diagnosis and Differential Diagnosis—With a variety of clinical possibilities such as are presented by histoplasmosis it is obvious that in order to make a diagnosis of this disease the organism *Histoplasma* must be demonstrated or cultivated In well advanced systemic cases the fungus can be demonstrated in smears of the peripheral blood stained with Wright's stain Biopsy from accessible lesions usually reveals the organism *Histoplasma* can also be found in smears from bone marrow as well as in the spleen liver or lymph node punctures Smears of sputum stools and urine may likewise show the organism *Histoplasma* is seen as a round to oval yeastlike cell with the nucleus eccentrically located near one pole The nucleus is often in the form of a signet ring Surrounding the cell is a clear nonstaining capsule or membrane

The disease causes confusion owing to its resemblance in many of its manifestations to malignant disease Cutaneous lesions among others may mimic leul emia cutis Oral lesions when ulcerated closely simulate carcinoma Anemia leukopenia and lymph node enlargement have led to clinical diagnoses of aleul emic leul emia lymphosarcoma lymphadenoma and aplastic anemia Lymph node enlargement when localized has been mistaken for Hodgkin's disease For further details see paper by Moore and Jorstad⁷

ASPERGILLOSIS AND MUCORMYCOSIS

Definition—Certain members of the Aspergillaceae such as *Aspergillus* and *Scopulariopsis* and those of the Mucoraceae as *Mucor Absidia* and *Rhizopus* known as the weeds of mycology may produce disease which is chronic inflammatory and granulomatous in nature

Clinical Manifestations—The organisms in general are not of the invasive type but are dependent more on the degree of lowered resistance of the organ to produce disease than on their ability to set up a reaction as strict pathogenic agents

The organisms show a special affinity for the pulmonary system primarily and secondarily for the external auditory canal mucous membranes of the conjunctivae cornea sinuses and the skin Cutaneous lesions are either gummatous eczematous with verrucous formations mycetomas ulcerations with or without lymphangitis These lesions may closely resemble carcinoma

Pulmonary involvement may be primary or secondary to some other

A case of this disease from our recent records is that of a 6 year-old white man who complained of a sore in the roof of the mouth (Fig 388). The sore had begun two months previously and had gradually increased in size but was not painful or tender. A biopsy taken from the right upper buccal sulcus was sent to the pathological laboratory with a clinical diagnosis of carcinoma of the buccal mucosa. *Histoplasma* was found in one small area of the biopsy specimen and the correct diagnosis established.

The following case perhaps establishes even more clearly the similarity of histoplasmosis to carcinoma. The patient was a 71 year-old white man who had



Fig 388



Fig 389

Fig 388—Ulcer of histoplasmosis in palate typically resembling squamous carcinoma and so diagnosed incorrectly in the clinic (Case of Moore and Forstad 1943)

Fig 389—Ulcer of histoplasmosis of the tongue incorrectly diagnosed clinically as carcinoma of the tongue (Case of Dr Shewin.)

an ulcer on the left side of the tongue (Fig 389). The lesion as it was 12 months duration. The tongue was painful and the patient complained of shortness of breath, orthopnea, and cough. On the assumption that the lesion was a carcinoma of the tongue, radium (radon seeds) was implanted. The lesion regressed somewhat but was followed by a marked inflammatory response which interfered with the patient's ability to swallow food. The correct diagnosis was established following treatment but the disease became generalized and the patient died.

Involvement of the nasal structures is usually considered as part of the oral lesion. Ulcers of the nasal mucosa occur usually as extensions from the oral lesions. Granulomatous lesions of the nares may be seen which are not unlike small tumor-like growths. The growth may in

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CARCINOMA OF THE LIP

MAJOR CLARENCE T. ECKERT MC AUS AND
JAMES L. PETRY MD†

THE term carcinoma of the lip will be used to designate only such lesions as have origin on the vermilion border or at the mucocutaneous junction. Lesions starting primarily on the mucous membrane of the skin with later extension to the vermilion border or mucocutaneous junction of the lip will not be included in this discussion.

This study is based upon 420 cases of carcinoma of the lip treated at the Barnard Free Skin and Cancer Hospital during the period of 1928 through 1939.

ETIOLOGY

A patient with a carcinoma of an exposed area such as the breast, skin or lip will often attribute the growth to a vague contusion or laceration. Such information is valueless. Not infrequently, however, we have seen a malignant tumor of the lip develop in direct relationship to irritation from a sharp tooth. All workers in this field concur in the opinion that the *poor oral hygiene* seen in most of these cases is a strongly influencing factor in the etiology of carcinoma of the lip. In this series not one malignant growth developed in a lip chancre and the incidence of syphilis was not higher than in normal individuals of the same social strata. Much has been written concerning the role of *tobacco* as an etiologic factor. The percentage of tobacco users in cases of lip cancer is about the same as in the general population, with perhaps a relatively larger number of lesions among pipe smokers.¹ The obvious question of course is why the incidence of lip malignancy in females has not increased in recent years as a result of the widespread use of tobacco by that sex. There is one type of cancer of the lip, however, that can be said to be an indirect but definite result of the use of tobacco. This is the malignant tumor which develops in a leukoplakia.

PREMALIGNANT LESIONS

Whether cancer develops from a single normal cell or whether it begins in abnormal diseased tissue we are unable to say. Bloodgood claimed that in 200 cases of cancer of the lip not one started in normal skin or mucous membrane. Broders¹ noted that the site of the malignancy was preceded by a sore or an ulcer in 63.3 per cent of the

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cases. It is very difficult to ascertain from the patient's history when premalignant lesions stop and cancer begins. Suffice to say those with very long histories most probably had antecedent lesions. Of our patients, 48.6 per cent said that they first noticed a scale or a wart over a year before first seen by us.

The most definite premalignant lesion is *leukoplakia*. The insignificance of syphilis in relation to cancer of the lip does not apply to leukoplakia. As stated above tobacco is a definite etiologic factor in the formation of leukoplakia. This lesion in its earlier stages is a non-palpable sharply demarcated faintly translucent white discoloration of the involved area. The lip lesions are frequently multiple and nearly always occur in conjunction with similar areas of the buccal mucous membrane and faulty oral hygiene. This condition may develop soon

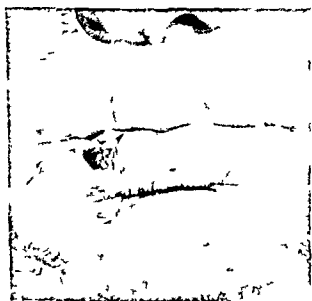


Fig 390—Carcinoma developing in an area of leukoplakia

after the tobacco user starts the habit or as is more often the case, after many years of heavy symptomless smoking. If untreated these lesions become opaque white finely granular papillary growths and are easily palpable. Later induration is noted. The cancer may be present in this induration or it may show as a typical malignant ulcer, the transformation usually taking place at the margin of the lesion (Fig 390).

Another frequent precursor of cancer of the lip is dry scaly *keratosis* which is of actinic origin or occurs with senility.

Common lesions such as the fever blister, cracked lip, and smoker's sore, if persistent, may develop into carcinoma. On occasion a carcinoma has developed in a superficial *granuloma* of the lip. This lesion is usually the result of injury³ as from a scratch or shaving. It is frequently accompanied by an early inflammatory enlarge-

ment of the regional lymph nodes and is often of a high grade of malignancy.

Heredity is probably not an important factor in the development of carcinoma of the lip. Careful study of the family history in this and other¹ series failed to reveal any connection.

INCIDENCE

A typical patient presenting himself for treatment of carcinoma of the lip might be described as a 55 year old farmer with a fair complexion. In our series only 13 (3.1 per cent) of the cases were in females. This is somewhat higher than Broder's¹ 2.04 per cent and the 2.8 per cent of Kennedy.⁴ Negroes rarely develop lip cancer; none of our patients were of this race. Newell² estimated that less than 1.5 per cent were in Negroes.

Lip cancer as other cancers is more predominant after the age of 40. Exceptions to this rule, however, are frequent; one of our cases occurring at the early age of 19. The division of our cases into decades is as follows:

20-29	30-39	40-49	50-59	60-69	70-79	80-89
11	29	58	101	127	76	22

The well known tendency for carcinoma of the lip to manifest itself in outdoor workers was again confirmed in this series of cases, 32.3 per cent being in farm workers. No other occupation warranted distinction in our series of cases.

SITE OF THE LESION

True carcinoma of the upper lip is vastly less frequent than that of the lower lip. Our cases revealed that in 18 instances (4.3 per cent) the lesions were of the upper lip. This is a somewhat higher percentage than that found by other workers. Wangenstein and Randall⁵ reporting 1.6 per cent and Kennedy⁴ 0.8 per cent of their cases involved the upper lip. The latter author also made an interesting study of the areas of distribution of cancer of the lower lip. He noted that the lateral lesions were equally divided between the right and left and that the lateral lesions were much more frequent than those of the middle one third of the lip.

SYMPTOMS AND CLINICAL DEVELOPMENT

There are no typical symptoms associated with cancer of the lip. Pain is rare except in some of the fissure type of lesions. The symptoms of even far advanced cases are those of tissue reaction to physical encroachment.

Primary Lesion—The primary lesion may present itself in any one of several forms. One type of lesion is the flat button like induration with no ulceration of the surface. As this type of involvement pro-

gresses its surface scales and crusts. Removal of this surface debris will usually reveal an ulcer. Another type of early cancer is the indurated crack or fissure which later develops into a rather typical ulcer. Perhaps the most frequent type of carcinoma of the lip is the



Fig 391—Fla., shallow ulcerating type of carcinoma with marginal induration.



Fig 392—Infiltrating type of carcinoma with deep deforming ulceration.

one which starts as an ulcer. This broad shallow ulcer is typical, having an indurated base and a firm border which is rolled and pearly (Fig 391). This lesion is essentially infiltrative in character and in some instances proceeds to develop into a fungating type of growth

Another type of ulcer is deep punched out with an indurated puckering edge (Fig. 392). The least frequent form of lip cancer is that type which starts as a papillary wart but later becomes malignant.

It is important to emphasize at this point that the clinical progress of any malignant tumor can be described only in broad, unbinding generalities. With this in mind we may say that the flat button-like lesion progresses and metastasizes slowly, the papillary wartlike lesion somewhat more rapidly, and the ulcerating infiltrative type of lesion most rapidly. Any of these clinical variations may assume markedly malignant tendencies in a very short time, even after having remained quiescent for long periods.

Metastases.—The early metastases of lip carcinoma are always via the lymphatic system to the regional nodes. Any deviation from this rule may be classed as a definite exception. The primary lymphatic drainage of the lips is into three groups of lymph nodes: the right and left submaxillary and the submental. The upper lip may be divided into a right and left half with each portion draining to the submaxillary nodes of its own side. The lower lip is roughly divided into three portions: a middle and two lateral thirds. The middle third drains into the submental nodes and the lateral thirds to their respective submaxillary nodes. All three of these groups of lymph nodes have freely interconnecting lymphatic channels. From these nodes the lymph drainage is to the upper group of the deep cervical nodes.

Carcinomas of the upper lip metastasize to the respective submaxillary nodes. Lesions of the lower lip are not so dependable. In general, carcinomas of the right and left thirds of the lower lip metastasize primarily to the corresponding submaxillary nodes, whereas the lesions of the middle third spread to the submental group of nodes. The paths of the metastases from lesions of the middle third of the lower lip are more predictable than are those from the lateral lesions. All workers in this field have noted that a carcinoma of one side of the lower lip may show its first metastasis to the submaxillary nodes of the opposite side. This irregularity of spread is also complicated by the frequent passage of the metastases to another or both of the remaining supra- and submental groups of nodes. In spite of this irregularity of spread to the submaxillary and submental nodes, the metastases to the next link of possible involvement, the upper group of deep cervical nodes, are quite dependable. That is, the metastases never seem to skip the submaxillary nodes before going on to the upper deep cervical group. Likewise the spread from the submental nodes always involves one or both of the submaxillary groups before reaching the cervical nodes.

In general, the time and degree of metastases vary directly with the age, size and type of primary lesion. The older, larger and more infiltrative types of carcinoma will metastasize earlier and more widely than the younger, smaller noninfiltrative types. However, it is a fact that lesions of seemingly low grade of malignancy may metastasize

earlier and more actively than do others that are frankly and viciously malignant

Moreland⁷ estimated that 20 to 25 per cent of patients presenting themselves for the first time for treatment of carcinoma of the lip have metastases to the regional lymph nodes and that less than 1 per cent have remote metastases. In our series of 420 cases when first seen 57 (13.6 per cent) had suprahyoid metastases and 8 (1.9 per cent) had involvement of the deep cervical nodes. These figures were taken from those patients who had neck dissections and are therefore only cases with *pro en* metastases. There are many others who did not have neck dissections but who later died of cancer; these patients undoubtedly had metastases when first seen.

In discussing metastases from lip cancer it must be remembered that not all palpable glands are malignant. Many carcinomatous growths are accompanied by an inflammatory reaction which results in secondary lymphadenitis. Similarly, and much more dangerous, are the metastases present in lymph nodes that are not palpable.

PATHOLOGY

Schreiner and Christy⁸ in analyzing 636 cases of lip carcinoma stated that they were all of the squamous cell type. Our study of 420 cases with microscopic sections revealed that 417 (99.3 per cent) were of the typical squamous cell variety and 3 (0.7 per cent) were of a mixed variety commonly called basosquamous carcinoma. Close study of the few of our cases diagnosed microscopically as basal cell carcinoma showed their site of origin to be doubtful. Basal cell carcinoma of the vermillion border or the mucocutaneous junction of the lip probably does not occur.

We formerly used Broders¹ method for microscopic classification of lip carcinomas into 4 grades of malignancy. With Blair and Byars⁹ we feel that microscopic grading does give positive evidence of malignancy to the extent of positive findings but does not exclude the presence of an unrevealed area of higher grade than that actually observed. This fact plus the capriciousness of the tumor led us to discard microscopic grading. We do not use it for determining the type of treatment to be given or for making a prognosis.

DIAGNOSIS

Cancer of the lip is not ordinarily a difficult diagnostic problem. To the experienced eye even the earliest lesions are rather typical. For the physician who does not see the early carcinomas regularly, however, they may not be recognizable clinically.

We need only bear in mind that any lesion of the lip which persists for more than 4 to 6 weeks should be considered malignant until proved otherwise. There is no excuse for not obtaining a *biopsy* in even the least suspicious case. Tissue diagnosis is now available to

every physician. Biopsy of the lip is a simple, painless, harmless procedure. In the course of hundreds of biopsies taken from lips we have not seen one case develop unusual growth or sudden metastasis as a result of this procedure. The tissue excised under local anesthesia of course should be large enough to enable the pathologist to obtain a satisfactory section for study. The best specimens for biopsy are those obtained with a sharp scalpel, thus avoiding tissue trauma. Also pathologists prefer a block of tissue radiating beyond the edge of the lesion into normal tissue, thereby permitting a study of the tumor, its invasive powers into normal structure, and the reaction of this normal tissue to the tumor. These factors are important (Fig. 393).

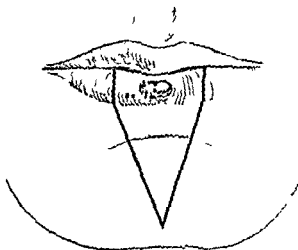


Fig. 393—Properly placed lines for edge of specimen and dotted outline of proper incision for biopsy.

The differentiation of the precancerous lesions from carcinoma is usually accomplished only by means of a biopsy. The chronic granulomas usually develop faster than a cancer, are not indurated and do not possess a rolled, pearly border. A chancre of the lip also develops faster than cancer and is accompanied by an early characteristic firm, rubber-like enlargement of the regional lymph nodes, which as a rule can be distinguished from the typical hardness of the malignant metastasis. Darkfield examinations, serology, and diagnostic therapy will help in making this diagnosis.

TREATMENT

No malignant growth of the body is more accessible to treatment than carcinoma of the lip. The primary lesion must be treated directly and completely. The submental and submandibular groups of lymph

nodes to which the vast majority of the metastases are limited are easily and completely removed

The first principle of treatment of any lesion is of course the removal of any etiologic factor. Therefore improvement of oral hygiene is always stressed. Sharp or jagged teeth and irritating dentures are remedied and premalignant lesions are dealt with. Smoking should be stopped.

Treatment of the Premalignant Lesion—The treatment of the premalignant lesion should perhaps be stressed even more than that of the subsequent carcinoma. Certainly the old adage concerning an ounce of prevention was never more true than when applied to carcinoma. The various premalignant lesions may be treated successfully by electrocautery, electrodesiccation or excision and suture. Premalignant lesions do not infiltrate and therefore the heat destruction or excision need not be deep. The best procedure is to anesthetize the area with procaine, excise the tissue for biopsy, and then immediately cauterize the entire lesion. Practically no deformity results from this method of treatment. Because of the ease and completeness with which these precancerous lesions are treated by this method we do not use nor advocate the use of radium in their therapy.

Treatment of the Primary Lesion—The treatment of the primary lesion of carcinoma of the lip is not a perplexing problem. Much has been written concerning the merits of surgery over radiation and vice versa. We believe that both of these methods are efficacious in curing the lip lesion and consequently use both of them. The important factor is not what method is used but rather the certainty of either complete removal of the cancer from the body or complete destruction within the body.

Perhaps the most efficient and least deforming procedure for dealing with the primary lesion of the lower lip is the simple *V lip excision*. This is a minor procedure, best done under local anesthesia. The arms of the V are started at least 1 cm. beyond the palpable margins of the lesion and are brought together at the apex of the V very low on the chin, preferably at the inferior margin of the mandible (Fig. 393). This long type of V excision removes more tissue and allows for closure without tension. The entire thickness of the lip is removed including buccal mucous membrane and all tissue down to the periosteum of the mandible. After the control of the bleeding, the arms of the V are approximated into a straight line with three layers of interrupted sutures: one for the mucous membrane, one buried row for the musculature, and one for the skin and vermillion border.

If care is exercised to approximate all margins minutely and especially the vermillion border skin junction of each side, a very satisfactory cosmetic result will be obtained. One need not hesitate to treat even large lesions in this manner. The fear of tightening the oral orifice into an unsightly pucker can be overcome when one remembers

that the lips are very elastic and as is shown by some of the aborigines may be stretched to almost unbelievable proportions. If after a period of waiting some deformity persists it can easily be corrected by any of the common mouth widening procedures. No further comments will be made in this paper concerning cosmetic results (1) because cancer is a life or death proposition and not a cosmetic problem and (2) because plastic surgery has progressed to the point that any patient can be made presentable once his cancer is cured.

Of the lower lip carcinomas in our series 299 were treated by excision and of these 281 (94 per cent) were free of local recurrence after a period of 5 years. It is not the purpose of this paper to discuss extensive surgical procedures for removal of the larger lesions. Needless to say practically any primary lesion is technically removable.

We do not limit the use of radium to any one type of primary lip cancer. More often than not however we have used it on the shallow noninfiltrating type of ulcer. All of these cases for radium therapy should have a biopsy previous to the treatment. We employed radium as a surface application to the primary lesion of the lip in 121 cases 109 (90 per cent) of which remained free of local recurrence after a period of 5 years. In 11 extreme cases with wide infiltration or extensive recurrent lesions we used interstitial radiation in the form of 1 and 2 mg gold filtered radium needles which were maintained in place for 5 to 7 days. Four (36.3 per cent) of the patients so treated survived 5 years free of local recurrence.

Roentgenotherapy to the primary lesion was used in only a small number of cases. The cases so treated were either considered inoperable because of the extent of the metastases or the extreme amount of infection present around the tumor. Often a carcinoma will be cause of this inflammatory reaction be adherent to adjacent structures. Roentgenotherapy favorably affects this perimalignant infection.

In our group were 18 patients with carcinoma of the upper lip. Of these 12 were treated surgically with 6 (50 per cent) free of local recurrence at the end of 5 years. 6 were treated by radium and of these 3 (50 per cent) survived 5 years without recurrence at the primary site.

Treatment of the Metastases.—The treatment of the primary lesion in cancer of the lip is not a subject of disagreement among the various authors probably because the results have been uniformly satisfactory with either surgery or radiation. Treatment of the metastases however has been the subject of extensive dissension. In fact Moreland⁷ stated that probably no other tumor condition is treated in more ways or regarding which opinion is more divided and treatment less standardized than in metastatic carcinoma of the neck. This healthful difference of opinion exists at the institution from which these cases are reported. The conclusions drawn by the authors there

fore are not to be interpreted as those of the entire staff. The points of contention concerning therapy of the lymph nodes are as follows:

1. Should the neck regions be subjected to therapy if the lymph nodes are not clinically palpable?
2. Should surgery or radiation be used as the basic method of treatment?
3. If surgery is the method of choice, how extensive should it be?
4. If radiation is the method of choice, should it consist of surface therapy or interstitial placement?

It is difficult to understand why proved principles of cancer therapy should be subject to deviation in the treatment of cancer of the lip. In all other carcinomas we strive to remove the primary growth and the sites of possible metastases. Yet in the lip, where the areas of spread are literally at our finger tips, there are those who advise no treatment of the lymph nodes until they become palpable. We realize that these workers have in mind the fact that about 80 per cent of patients with no palpable lymph nodes will remain well following the cure of the primary lesion.¹⁰ It has been found, however, that cancer is frequently present metastatically in lymph nodes that are not clinically palpable. Kennedy¹¹ found microscopic cancer in the lymph nodes of 14 per cent of the patients in whom the nodes were not palpable, and Taylor and Nathanson¹ estimated this same factor at 20 per cent. In our series there was a high percentage of palpable nodes, but, as stated elsewhere in this paper, palpability does not necessarily indicate malignancy. Except in certain far advanced cases we lay little significance on the palpability of the nodes.

It will be noticed that the controversy concerning removal of the lymph nodes has centered around the early cases, those in which the regional lymph nodes may not even be palpable. These same patients are the ones with the best chance of survival: (1) because metastases are the ones with the best chance of survival, and (2) because the submaxillary and submental groups are not found when the lymph nodes are not clinically palpable, and (3) because these are the patients who can be operated upon with a very low mortality rate. In our series there were 219 cases of block dissection of the submaxillary and submental areas for carcinoma of the lip with 15 operative deaths, a percentage of 6.9. This is indeed a relatively high operative mortality. It must be borne in mind, however, that these cases are reported from an institution catering entirely to charity patients, and that though many of them were very poor operative risks, they were given such chance for cure as was in our power to give them. The actual operative mortality rates are much lower, of course, in private practice and other types of institutions. For example, Broders¹ reports this figure as 0.77 per cent, and Figg¹³ as 0.42 per cent. To break down further, our 219 operative cases, 57 (26 per cent) showed microscopic metastases, and of these 24 (42.1 per cent) survived the

5 year period clinically free of cancer. Of the remaining 162 (86.4 per cent) without histologic spread there was a similar survival of 121 (76.4 per cent).

These figures were obtained on the basis of actual follow up of the patients. Those who were lost track of or who were reported to have died of intercurrent disease were presumed to have died of cancer. Undoubtedly many of these patients survived 5 years without evidence of cancer. In this entire series 62 (12.4 per cent) were lost track of or died of intercurrent disease before 5 years. This is due to the fact that a large number of our patients are drawn from a wide area and many are transients making follow up sometimes very difficult.

Thus it is seen that we favor the removal of the primary growth and a *block dissection of the submaxillary and submental groups of nodes* for early carcinoma of the lip. Technically the suprahyoid neck dissection is not too involved. The block of tissue which includes the platysma muscle, the submaxillary salivary glands, the three lymph node groups and the inferior portions of the parotid salivary glands is removed en masse usually under local anesthesia. A portion of the facial artery extending from the posterior belly of the digastric muscle to the anterior surface of the mandible is excised on each side. The lingual and hypoglossal nerves are easily identified and left intact. Because of the frequent occurrence of cross metastases from carcinoma of the lip we do not advocate the use of the unilateral submaxillary triangle dissection.

Thus surgery is the basic method of treating the areas of metastasis from cancer of the lip. In our experience surface roentgenotherapy has proved to be of little value in this field. We use it only in the far advanced inoperable cases or to deal with a suspected accompanying infection.

Our few cases treated with interstitial radiation of the lymph nodes were too far advanced and too infrequent to permit us to draw any conclusion concerning this type of therapy.

As stated earlier carcinoma of the lip never metastasizes to the upper group of deep cervical nodes without first involving the suprahyoid nodes. Metastasis to the upper group of deep cervical nodes is a sign of very late involvement to be compared with supraclavicular metastases from carcinoma of the breast. For this reason we feel that the logical treatment of the relatively early lip cancer should be limited to the local lesion and the suprahyoid neck dissection. In the further advanced cases marked by metastases to the deep cervical nodes surgery is advocated but with little hope of cure. We did complete neck dissections on one or both sides of 13 such patients and only 3 (23 per cent) were alive after the 5 year period.

Preoperative or postoperative radiation is not used routinely as we have not found such procedures to influence noticeably our results. In the jungle of statistics a tree can be found to support any conten-

tion, and it is safer to treat a patient from the background of experience rather than from the maze of statistics

One of the most important parts of the cancer therapy regimen is the never-ending series of follow up examinations. These must be meticulous and complete. If they are carried out in a desultory sort of manner the patient will soon decide that they are of no further importance and fail to report regularly.

SUMMARY AND CONCLUSIONS

1 Premalignant lesions precede a large proportion of carcinomas of the lip. Constant alertness will lead to prompt diagnosis and treatment of these lesions with the prevention of subsequent cancers.

2 Cancer of the lip is largely a disease of the lower lip of the middle aged fair-complexioned male frequently having a rural occupation.

3 Biopsy is the only safe method of diagnosis.

4 The clinical appearance or even microscopic examination of a carcinoma of the lip does not safely indicate the present extent or the future progress of the lesion.

5 Carcinoma of the true lip areas is a squamous cell lesion which will metastasize early to the submaxillary or submental groups of lymph nodes but rather late to the upper group of deep cervical nodes.

6 Surgery is the basic method of treatment both for the primary lip lesion and for the metastases.

7 A routine suprahyoid neck dissection should be done in every early case of cancer of the lip even if no lymph nodes are palpable.

8 Meticulous follow up examinations should continue for the life of the patient.

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CANCER OF THE TONGUE ITS DIAGNOSIS AND TREATMENT

LOUIS H JORSTAD M.D.,* AND D J VERDA M.D.†

THE IMPORTANCE OF EARLY RECOGNITION

In a discussion of the diagnostic features of tongue cancer it is most important to emphasize those which aid in establishing an *early* diagnosis. It has been definitely determined in a study of this group of cases particularly in comparing the Barnard Hospital with the private (L.H.J.) group that not only is the prognosis more hopeful if the primary lesion is controlled in the early stages of the disease but metastasis may not occur in the secondary (metastatic) zone of lymphatics if the primary lesion is eradicated in the early stages of its growth. There are a certain number of cases in which no evidence of metastasis has been noted 5 to 10 years following control of the local lesion. In the private series this is 70 per cent. In the Barnard series this is 45 per cent. This difference is definitely due to a greater percentage of early cases in the private than in the Barnard group.

This observation is important from the standpoint of the general attitude of the attending physician towards the treatment of the metastatic zone. It is our opinion that in the majority of cases seen at this early stage, resection of the lymph bearing tissue is only not necessary but is contraindicated. This is important to consider because of the definite percentage of cases that have shown no evidence of metastasis up to 10 years following eradication of the primary lesion. Furthermore the operative procedure has an appreciable mortality particularly in older individuals. The postoperative mortality following deep cervical lymphatic resection in the private (L.H.J.) series is 1.6 per cent and in the Barnard series is 7.2 per cent. Irradiation of the metastatic zone has proved disappointing and not curative in definitely metastatic lymph nodes thus prophylactic irradiation is of questionable value. We have discontinued its use for this purpose. Resection of the lymph bearing tissue in the metastatic zone is indicated always in the presence of probable or definite metastasis. Resection of the lymph bearing tissue is not indicated unless the lymph nodes are increased in size and the increase in size is due to no other factor but the carcinoma of the tongue.

DIAGNOSIS

The Primary Lesion—An early lingual cancer is one which is of a few weeks duration is not over 2 cm. in its greatest dimension, and has

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no lymph nodes palpable in the drainage zone. The histologic grade of malignancy is of significance in estimating prognosis and in certain selected cases it is of value in planning treatment. This last factor is of particular significance in the borderline cases from the standpoint of treatment examples of which are the markedly anaplastic (grade IV) carcinomas with definite but still operable metastases in the neck. In these cases where a biopsy of the tongue lesion has revealed a grade IV carcinoma there should be a radon implantation into the primary area and x radiation to the gland bearing area of the neck. This group in our experience has been very small 3 per cent in the private and 3 per cent in the Barnard series.



Fig. 394—Ulcerative type of carcinoma of tongue

The primary lesion of the tongue usually appears clinically in the form of an ulcer with an irregular border (Figs. 394-395 and 396). The border and base of the lesion are woody and hard in consistency. This consistency is spoken of as an induration and is of a hardness which is more distinct than the brawny induration of a low grade infection with fibrosis. Scar tissue has a certain rubbery consistency or resiliency. So long as the lesion is small in size it usually remains free of necrosis; thus it presents a reddish granular base similar to the projecting border. As the lesion increases in size, necrosis becomes a more prominent feature and may be seen in the base irregularly distributed along the edge or both. The necrotic portion is soft and this explains

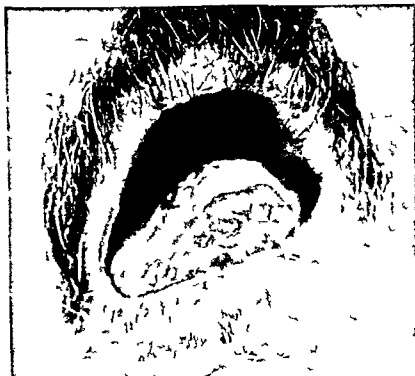


Fig 395—Ulcerative type of carcinoma of tongue with fixation to floor of mouth

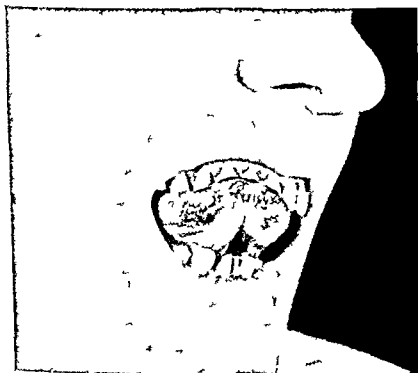


Fig 396—Ulcerative type of carcinoma of tongue and floor of mouth

why the carcinoma with necrotic base may present induration along the edge only

A small percentage of the cases are of the nonulcerative type the lesion presenting an everting cauliflower like growth (Fig 397)

Differential Diagnosis—The chief lesions to consider in differential diagnosis are *syphilis* and *tuberculosis*. A positive blood Wassermann, Kahn or Kline test does not signify that the lesion of the tongue is syphilis despite the presence of a primary secondary or tertiary syphilide on some other part of the body. A careful history careful observation of behavior of the lesion under antisyphilitic treatment and biopsy are essential in the diagnosis. Strict adherence to the principle that cancer of the tongue does occur in an individual with syphilis will avoid the most serious pitfall of allowing a cancer of the tongue to advance beyond the hope of eradication while the patient is being



Fig 397—Nonulcerative type of carcinoma of tongue

treated for syphilis. These conditions can and should be treated constantly. The percentage of latent syphilis in patients with carcinoma of the tongue is essentially the same as the percentage of syphilis in the general clinic or private practice population. Syphilis was present in this private series in 4 per cent and in the Barnard group in 12 per cent of the patients with carcinoma of the tongue.

Regional Metastases—The most important group of lymphatics in relation to the diagnosis and treatment of lingual carcinoma is the deep cervical chain. This is the chain of lymph nodes and vessels that encircle the deep jugular vein and extend from the clavicular fossa to the mastoid process (Fig 398). The posterior third of the tongue drains directly into this chain of lymphatics and on account of the

marked decussation of the lymphatic vessels in this area of the tongue contralateral metastasis is not uncommon (The importance of this factor will be discussed under Treatment of Metastasis) In the middle third of the tongue decussation of the lymphatics is not so marked and metastasis is usually to the deep cervical chain of the affected side however the submaxillary group of the affected side may be involved first The route of metastasis from the anterior third of the tongue is to the submaxillary group as well as the deep cervical chain Thus in all cases of lingual cancer the deep cervical chain of lymph nodes must be carefully observed Because the submaxillary nodes are important as a direct route of metastasis from lesions in the anterior two thirds of the tongue we include the contents of the submaxillary space in resection of the deep cervical lymph bearing tissue in all cases require

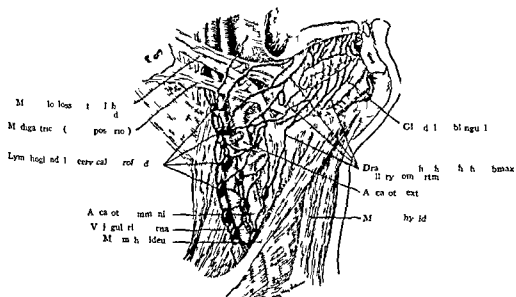


Fig. 398—Lymphatics of the tongue (Poirier and Charpy)

ing resection of the lymph bearing tissue Furthermore retrograde metastasis will occur from the deep cervical chain to the submaxillary group

We have discontinued *aspiration biopsy* of lymph nodes of the neck in these cases. In case of the large hard node it is not necessary for the establishment of diagnosis. In the slightly enlarged and hard node a negative biopsy is not ample evidence to warrant delay of dissection because of the great probability of failure to obtain the biopsy specimen from that portion of the node containing the metastatic area. Thus in a patient with carcinoma of the tongue an enlarged lymph node in the metastatic zone of the neck must be considered a probable metastasis if there is no other apparent condition in the primary or secondary zone which could account for the enlargement.

In evaluating the significance of an enlarged deep cervical node or group of them the status of *oral hygiene* in the particular case must be considered. A low grade infectious process of the alveolus or tooth roots is most probably responsible for such an adenopathy. An acute inflammatory process in the mouth and in the cervical nodes is readily evaluated and differentiated from a neoplastic process because of its acute nature manifested by pain, tenderness, swelling and redness.

TREATMENT

The Lesion of the Tongue—During the past 5 years we have not excised any portion of the tongue for the cure of cancer. Surgery has proved to be disappointing as a means of eradicating carcinoma of the tongue. In the first place, removal of half or all of the tongue produces a social outcast. It is extremely difficult for the patient to speak with any degree of clarity after these procedures. In the second place, the postoperative mortality following glossectomy is prohibitive, particularly is this true when considered from the standpoint of proneness to recurrence of the neoplasm following this radical surgical procedure. The very high mortality following the combined operation of resection of half of tongue plus deep neck dissection contrasts markedly with the safer procedure of *radon implant* into tongue *plus deep neck dissection*. The anatomical arrangement of the tongue and floor of the mouth is such that even a total amputation of the tongue does not allow a satisfactory margin of normal tissue. This is particularly true if the carcinoma involves the edge or undersurface of the tongue, even disregarding the lymphatic vessel network.

With the advent of *radium* in its various forms we have attempted to obtain adequate irradiation by the surface and interstitial routes. In our experience, radium applied to the surface and retained there by use of moulages has proved unsatisfactory. The changes in form, size and position of the tongue due to its muscular makeup cause this method of irradiation to be most inaccurate. The removable radium needle of 1 mg. per centimeter length has proved unsatisfactory. The tongue is a mobile structure and these needles do not remain in place during the required period of 4, 5 or 6 days. Then too, these needles are uncomfortable in the tongue.

Radium emanation in the form of the gold seed or gold radon implant has in our experience been the most satisfactory treatment. We have used the 1 millicurie glass or gold radon seed, but the radiation was inadequate and recurrences were too frequent. Since using the 1.5 millicurie radon seed, implanting them 1 cm. apart surrounding and into the lesion if necessary, our clinical results have been much improved. The percentage of incomplete regression has been 36 per cent in the total group of cases. In neither group was there any selection on the basis of curability, the palliative cases being included in the total tabulation. Cases up to 5 years ago were studied, 55 in the

Barnard Hospital and 50 in the private series, or a total of 88 cases. In other words, 64 per cent of the Barnard series and 90 per cent of the private series showed no evidence of local recurrence or incomplete regression of carcinoma in the tongue following implantation of radon. These seeds are implanted under general anesthesia to avoid the necessity of infiltrating locally with anesthetic solution. The placement of these seeds must be accurate and this is possible only into a nonresisting tongue. Intravenous sodium pentothal or inhalation anesthesia is satisfactory. Preparation for anesthesia is the same as for any other procedure requiring a general anesthetic.



Fig. 99—Regression of carcinoma 3 months following "radon." Same case as in Fig. 396.

Local reaction from the radon begins within 48 to 72 hours and reaches its maximum within 2 to 4 weeks at the end of which time it begins to subside. During this period there is considerable discomfort due to the swelling and salivation. Fluid and caloric intake must be urged and mild sedation is usually ample. The extent of the malignant involvement and necessarily the amount of radon used governs largely the degree of discomfort. Lesions in the posterior third of the tongue however are usually the most uncomfortable because of the contiguous pharyngeal and buccal mucosa undergoing secondary reaction from the irradiated tissue of the tongue. These are the cases in which particular urging is required to maintain satisfactory fluid and caloric intake. Adequate fluid intake, however is the most satisfactory means

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of preventing excess of tenacious mucus and alleviating the discomfort of the dry mucosa that is due to the inflammatory reaction. Local medicaments are largely unsatisfactory, frequent washes or light irrigations with normal saline being most beneficial.

At the end of 2 months a soft pliable smooth area should have resulted (Figs 399 and 400). In a small percentage of cases, particularly if the lesion is large and involves the floor of the mouth, it will require 1 or 2 months longer for the central area of the necrosis to separate and fill in with granulation and scar tissue. Persistent induration, particularly if distributed irregularly in the area, is indicative of recurrence.

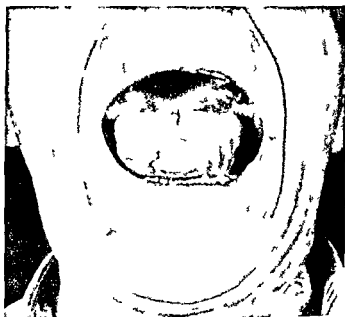


Fig 400—Regression of carcinoma 3 months following Fig 397. Same case.

Metastatic Zone (Regional Lymphatics)—The node in the deep cervical chain involved first in the majority of cases of lingual cancer is the jugulodigastric lymph node (Fig 401). It could well be considered the sentinel node of the metastatic zone. It lies at the lower edge of the digastric muscle as it crosses the deep jugular vein. From the clinical and anatomical standpoint there is considerable difference of opinion regarding the relationship of the supraclavicular lymph nodes to the deep cervical chain. Some maintain the supraclavicular and deep cervical to be separate groups of lymph nodes. From the clinical standpoint extension to the supraclavicular nodes from the deep cervical and posterior jugular chain is frequent enough that the supraclavicular group should be included in the neck dissection. This

is particularly important if the node below the jugulodigastric lymph node is grossly malignant

During a period of 2 years in a series of 24 cases we did not include the supraclavicular nodes but started the lower level of dissection at the level where the omohyoid muscle crosses the internal jugular vein. We did this in cases where the nodes below the jugulodigastric node were grossly not malignant. Supraclavicular metastases occurred at a later date however in 25 per cent of these cases. This was particularly evident if the posterior jugular chain of nodes was involved. The internal jugular vein is always included along with the carotid sheath in this dissection. It is impossible to remove the lymphogenous tissue



Fig 401—Enlarged jugulodigastric lymph node

from the jugular vein and carotid sheath. The sternocleidomastoid muscle is cut across at its clavicular attachment and all these structures with connecting fascia are removed en masse, the upper limit of the dissection being the skull (Fig 402). Thus the neck dissection necessary for the removal of the metastatic zone of tissue from carcinoma of the tongue is the deep cervical posterior cervical and submaxillary group of lymph nodes. The anterior edge of the trapezius muscle marks the posterior margin and the midline of the neck the anterior margin (Fig 403). There is no permanent functional disturbance resultant from this dissection. Within 3 to 4 months time the neck and shoulder movements are essentially normal. The cosmetic result is determined largely by the prominence of the sternocleidomastoid mus-

cle. In the average individual the deformity is not marked (Fig. 404)

In further analysis from the standpoint of total survival in the Bar-nard group treated by surgery alone 6 of 51 patients (11 per cent) survived 5 years or more. In this group 45 per cent had palpable nodes on the same side of the neck as the tongue lesion and 7 per cent had bilateral lymph node enlargement.

In the group in which radon was used in the treatment of the tongue lesion and in which the lymph bearing tissue was resected when in a



Fig. 40 —Dissection showing block of lymph bearing tissue as it is removed en masse

cated 10 of 55 patients (18 per cent) survived 5 years or more. In this radon group 71 per cent had enlarged cervical nodes upon the first examination in the clinic. Nine per cent had bilateral enlargement of the cervical lymph nodes.

In the private group 30 per cent of the patients had enlarged cervical lymph nodes on first examination. The regional lymph bearing tissue was resected in each case. Sixty per cent of these patients showed

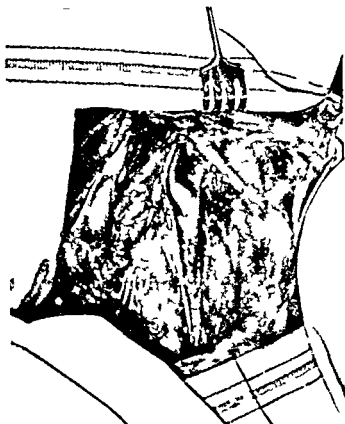


Fig 403—Dissection completed showing carotid artery vagus nerve digastric muscle and lower edge of mandible as essential landmarks



Fig 404—Cosmetic and functional result 7 months following dissection

histologic metastasis. The 5 year survival is 66 per cent in this group of 30 cases.

This demonstrates the great advantage of early recognition and treatment of carcinoma of the tongue. The patient with bilateral deep cervical metastasis is hopeless from a curative standpoint. On account of the necessary removal of the internal jugular vein an interval of 4 to 6 months is necessary between each unilateral deep neck dissection. An already enlarged lymph node has usually become fixed to the carotid artery during that period.

Palliative Treatment—In addition to sedation more direct palliative methods are often of real benefit particularly in cases in which the life expectancy may extend over a period of months. In the palliative group we include those cases with definitely inoperable cervical metastasis, distant metastasis or a lesion of the tongue extensively involving contiguous structures especially in the pterygoid or mandibular area. Each of these cases particularly requires individual consideration, as well as the closest cooperation between the surgeon and radiologist. Cautery or diathermic removal of necrotic masses or dead bone, alcohol injection or surgical section of nerve trunks, section of sensory roots, interstitial and γ radiation within tissue tolerance are of value when used alone and in combination. Tracheotomy for respiratory difficulty is seldom necessary. Nasal intubation to maintain or augment fluid and caloric intake is important where intake by mouth is painful.

SUMMARY

1. Radium emanation in the form of the gold radon seed implanted into the tongue has proved to be the most satisfactory method for controlling cancer of the tongue.

2. Adequate radiation of this type averages approximately 60 mg hours of radon destroyed per cubic centimeter of tissue.

3. Surgical resection of the lymph bearing tissue in the secondary drainage zone (neck dissection) is the treatment of choice in controlling metastasis.

4. The importance of early recognition of cancer of the tongue is emphasized.

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THE SURGICAL MANAGEMENT OF CANCER OF THE LARYNX

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In the last two or three decades such great advancement has been made in the surgical treatment of cancer of the larynx that this disease now yields as favorable results comparatively as are obtained in breast, lip and genital cancer. If untreated, the disease results invariably in a painful, agonizing prolonged period of suffering and a death by gradual choking.

The early symptoms and late metastases in intrinsic cancer of the larynx permit early diagnosis and offer an excellent prognosis if the patient and the first physician he sees realize the seriousness of the condition and recognize the high percentage of cures obtainable in early cases. Where cervical metastases are already present, the outlook is less favorable, but still encouraging in some cases. Where the primary growth arises literally or external to the larynx as in the piriform fossa, still more extensive metastases are often found, before the growth involves the larynx sufficiently to produce hoarseness and causes the patient to seek relief. However a cure can be obtained in some such cases and in almost all of them comfort and palliative relief can be provided by surgical excision of all of the involved areas.

DIAGNOSIS

Symptoms.—The early symptoms of carcinoma of the larynx are (1) persistent hoarseness without cough and without a known cause as recent sore throat, in persons over 50 years of age, and (2) frequent, sharp sudden pains in the larynx, pharynx or ears. Later symptoms may be difficult breathing especially on slight exertion, or the appearance of nodes in the sides of the neck. Blood-streaked mucus or definite hemorrhage may occur.

Differential Diagnosis.—Syphilis and tuberculosis of the larynx are the most common conditions giving most or all of the above symptoms and can be ruled out by biopsy, serological and sputum tests. Nerve injuries as in gopher operations or wounds of the larynx may cause hoarseness and sometimes dyspnea. Old scars of inflammatory origin following diphtheria or inhalation of caustic fumes may also produce hoarseness or laryngeal stenosis. These can be eliminated by a careful history and by inspection.

Methods of Examination.—*General*—(1) All patients having persistent

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hoarseness should have a Kahn test made and if positive be treated at least 2 weeks remembering that syphilitics may also have cancer (2) Careful sputum and chest examinations for tuberculosis should be made (3) Palpation for discrete lymph nodes in the neck especially along the deep vessels may reveal inequalities and possible metastases

Special—(1) Palpation of the pyriform fossae at the sides of the larynx and (2) palpation of the base of the tongue for thickened or indurated areas is done. Cancer originating in the base of the tongue lateral pharyngeal pouches or posterior wall often involves the larynx (so called extrinsic cancer of the larynx) and has a much poorer prognosis because of great involvement before laryngeal symptoms arise (3) Visual inspection by mirror or direct laryngoscopy may show an ulcer or a tumor (4) A specimen should be removed for microscopic examination. This procedure is best done by a competent laryngologist

Laryngofissure—Laryngofissure may be necessary to confirm some cases where the growth is below the vocal cords and cannot be visualized from above. This consists in splitting the larynx through the midline of the neck spreading it apart inspecting the subglottic space and removing suspicious areas for microscopic confirmation. If the area of tumor or ulceration is only 3 or 4 mm broad and on the margin of a vocal cord local excision and cauterization of its base might suffice to cure the patient of his disease. Benign tumors of course require only simple removal of the growth either through the oral route or by laryngofissure.

INDICATIONS FOR LARYNGECTOMY

Definite carcinoma (or sarcoma) as proved by biopsy in an otherwise operable patient is in my opinion best treated by laryngofissure only if the lesion is very small and easily removable otherwise by a total laryngectomy.

MENTAL PREPARATION OF THE PATIENT FOR LARYNGECTOMY

Any surgical procedure which results in such greatly altered physiological functions or habits in a patient as does a laryngectomy should be preceded by a careful and painstaking explanation of the necessary changes that will ensue. It is his cancer and his larynx and he may elect to retain it or have it removed as he chooses. The following questions and explanations have been helpful in my practice to explain these changes.

1 *Is any other treatment effective?* Some cures or regressions have been reported by x-ray. I have never seen one and I long ago abandoned the use of radium because it produced a profound perichondritis often caused sloughing and usually caused a stenosing edema which required a tracheotomy.

2 *Will I always have to breathe through the tracheal opening?*

my neck? Yes but it has some advantages You will not strangle while eating or drinking as the mouth becomes entirely separate from the air passages You will not be able to breathe through your mouth or nose

3 *Will I be able to talk?* Yes if you procure and learn to use one of the excellent types of artificial larynxes on the market at a cost of \$25 00 to \$50 00 each Several of my patients talk quite well without an artificial apparatus in fact some speak better than before they were operated upon for then they could barely whisper They learn to swallow air and re expel it through the mouth making an audible belch or burp and modify it into intelligible speech Patients may be helped in this procedure by drinking large amounts of carbonated beverages and training themselves to control the eructations of gas and modify the sounds into words before removing the larynx

4 *Will I have to wear a tube indefinitely?* Possibly so but frequently the tracheal opening will remain large enough without requiring the use of a tube I explain to them that for a few weeks until the throat heals and they can swallow normally without the food leaking out they must be fed through a nasal tube The average time of healing is from 3 to 4 weeks but with some of my patients we were able to dispense with the nasal tube in 2 weeks

I also tell my patients that following the operation they must write their needs and wishes on a pad of paper or slate until healing is complete and they can talk My best patient in that respect was urged to purchase an artificial larynx in 2 weeks practice a week and return to the office for some instructions He came handed me the apparatus talking plainly without it and informing me that he would have no use for it

I also explain to the patient that the postoperative condition of the wound will be quite messy for several days in case he coughs up much mucus or his throat wound heals slowly permitting leakage through the wound for a while He is also told that his appearance will not be objectionable after healing takes place for his shirt will cover the opening and also permit warming of the air he breathes I have found that such a careful explanation of the probable postoperative course enables the patient to cooperate more readily and willingly and to avoid undue alarm at the minor complications which arise If he wishes he may talk with a patient who has had the same operation performed see how he gets along and get his opinion as to whether it has been worthwhile to him

The patient will probably want to know how dangerous the operation is I have not lost a single private patient who came in the earlier stages of his disease and have lost but 2 private patients in all both nearly moribund when operated upon One of them was told a year previously by his family doctor not to have the operation performed This patient had to have an emergency tracheotomy 3 months later

and came to me 9 months after the tracheotomy obstructed again. A kindly but ignorant nurse allowed his tube to become occluded with mucus the night following the operation and he choked to death. The other death also followed an operation performed in extremis when obstruction was almost complete after a year and a half of x-ray treatment. The patient developed a bronchopneumonia and died on his eighth postoperative day. Two deaths occurred in my clinic patients where I did not have full charge of the after treatment. Both were from bronchopneumonia due no doubt to aspiration of purulent material leaking from the mouth. All types of cases considered my operative mortality has been about 20 per cent. Tracheotomy alone is often quoted as having a mortality rate of 20 to 30 per cent.

From 1920 to 1929 inclusive there were 9 laryngectomies performed at the Barnard Free Skin and Cancer Hospital with 5 postoperative deaths or 55.5 per cent. In the same period 1 larynx fissure with excision of the tumor on the cords was done and the patient died postoperatively. Four hemilaryngectomies were done in this period with 3 postoperative deaths. From 1905 to 1919 inclusive 2 laryngectomies were done, 1 patient dying after operation. It is apparent that in later years our primary operative mortality has been reduced from over 50 per cent to slightly less than 25 per cent. This includes all cases both fairly early and late intrinsic and extrinsic.

From 1930 to 1939 inclusive 9 laryngectomies were done with only 2 postoperative deaths. Three patients in this series are still alive and free from recurrence. From 1940 to April 1, 1944, 12 laryngectomies have been performed by Dr. Louis H. Jorstad or myself with 3 postoperative deaths and 9 recoveries. Hence improvements in operative technic for the period 1930 to April 1, 1944 resulted in 16 survivals after 21 laryngectomies giving a primary operative mortality of 23.5 per cent.

Among my own cases at the Barnard Hospital in which operation was done, 6 patients survived and left the hospital and 2 died both of postoperative hemorrhage.

In my private practice and in my practice in other clinics I have had 13 survivals and 3 postoperative deaths, a primary mortality rate of 15.8 per cent. Three of my patients in the Barnard Hospital group and 8 in the second group are still alive and well, the survival period extending up to 17 years in the second group. One private patient died after 5 years of cerebral hemorrhage but had no recurrence of his carcinoma.

PREOPERATIVE PREPARATION OF THE PATIENT

Decayed teeth should be extracted or repaired if possible because they are a constant source of infection. The teeth should be well brushed and the mouth rinsed frequently with any suitable mouth

wash which is acceptable to the patient for 2 or 3 days before the operation I prefer the use of a teaspoonful of salt dissolved in a glass of warm water to which has been added a tablespoonful of hydrogen peroxide. If this is used every half hour while the patient is awake the mouth will be fairly clean. Plenty of sweetened fruit juices and other fluids and a liberal soft diet should be taken on the day previous to the operation.

Nembutal or seconal $\frac{3}{4}$ grain at bedtime assures a more restful night. A preoperative hypodermic of morphine grain $\frac{1}{4}$ and atropine grain $\frac{1}{150}$ is given a half hour before operation unless avertin is to be used as the anesthetic in which case the morphine is omitted. If the operation is to be done under local anesthesia I prefer an HMC (hyoscine morphine cactine) tablet No. 1 hypo given $1\frac{1}{2}$ hours before the time set followed by an HMC tablet No. 2 $\frac{1}{2}$ hour before the operation unless the patient's respiration rate is below 12 per minute. This gives an excellent preanesthetic twilight. Nembutal grain $1\frac{1}{2}$ given orally 1 hour before going to the operating room also gives an excellent twilight anesthesia.

The *choice of anesthetic* is a matter of personal preference but some consideration should be given to the physical condition and temperament of the patient. Highly nervous patients do not cooperate well if a local anesthetic is used. In my own practice I use 0.5 per cent procaine solution with 3 or 4 drops of adrenalin to each ounce blocking the cervical nerves at the posterior border of the sternomastoid muscles infiltrating the incision lines in the skin and infiltrating the tissues around the larynx itself. Regardless of the type of anesthetic used I infiltrate some procaine solution into the tracheal wall before cutting it across in order to prevent or minimize coughing at that time.

Avertin 80 mg per kilogram of body weight prepared and instilled into the rectum is an excellent basal anesthetic for this work.

Ether given by the drop method for induction or until the pharynx is opened followed by ether vapor blown into the trachea is quite satisfactory.

The stage of anesthesia should be rather light barely subduing the swallowing or coughing reflexes.

The *position of the patient* should be supine with the head well extended. The skin is sterilized by any preferred antiseptic solution painting the lower lip and to the ears above and half way to the nipples below. I drape a large sheet over the patient's body spread a towel across the chest at the level of the clavicles then place a towel obliquely along each side of the neck to the mastoid process. I then place a fourth towel or a small sheet transversely from the chin to each mastoid anchoring it with clips to the chin and to each mastoid area grasping the oblique towels at the latter points. This gives a suitable field in which the surgeon and his assistants can work easily.

TECHNIC OF TOTAL LARYNGECTOMY

The incision may be one of several standard ones. Mackenty's T incision gives an excellent exposure of the entire larynx. A transverse incision 4 or 5 inches long is made through the skin and platysma muscle at the level of the hyoid bone. A vertical incision is now made in the midline from the transverse incision downward to the suprasternal notch. The lateral flaps are now reflected as far as the anterior borders of each sternomastoid muscle. The superior flap needs little or no undercutting. The thyroid isthmus is carefully pushed down, if small or divided in midline and pushed to the sides of the trachea, if necessary, to permit the trachea to be brought forward. The cer-

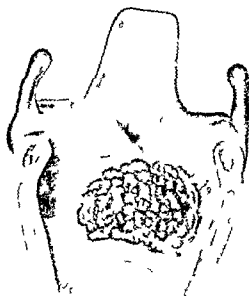


Fig. 405.—Drawing of specimen of intrinsic larynx in a patient hoarse for 18 months. Patient is active and well today, 17 years after operation.

vicul fascia in front of the trachea is now incised in midline and retracted laterally along with the sternohyoid muscles if the cervical lymph nodes are not involved. I have found that leaving this muscle intact on one or both sides stabilizes the base of the tongue and hyoid bone helps prevent undue movement of the pharyngeal suture line and tends to promote more prompt healing of the wound in the pharynx. The larynx is further dissected or skeletonized by sectioning the constrictor muscles laterally, gently reflecting the anterior pharyngeal wall to the first tracheal ring, separating the epiglottis from the hyoid bone and freeing the cornua of the thyroid cartilage which project posteriorly. The lateral pharyngeal wall is now opened above the

cornua of the thyroid cartilage and the interior of the larynx or pyriform fossae and the pharyngeal wall are directly inspected and if involved they are excised a centimeter or two beyond all suspicious margins

The larynx can now be removed either from above downward severing its pharyngeal attachments completely under direct visualization or by cutting across the trachea (see below) and removing it from below upward in the former technic. An assistant holds the larynx out of the way to prevent drainage of blood or saliva into it and to prevent its compression until the pharyngeal opening is closed. The feeding tube is now guided under direct visualization into the



Fig 406—Drawing of trapdoor flap with base upward used in removal of larynx pictured in Figure 405

esophagus. I use interrupted silk tied in the pharynx or a Connell type suture of hard catgut inverting the mucosa into the pharynx. If there is any undue strain on the suture line the hyoid bone should be cut completely across in the midline to relieve tension and to favor healing. The constrictor muscles are now sutured in front of the pharynx and the cervical fascia and opposing sternohyoid muscles are brought together in midline in front of the constrictor muscles.

The larynx is next severed by an oblique incision from the second or third tracheal ring in front to the first ring level posteriorly making a flap on the posterior surface that can allow better attachment of the trachea to the skin. If the trachea is cut obliquely across early



Fig 40—Final result of operation for cancer shown in Figure 405. Patient does not require a tracheotomy tube.



Fig 408—Result of trapdoor flap. Flap base at the left.

and the larynx removed from below upward it is more difficult to prevent saliva or blood from trickling down into the trachea unless an assistant holds it carefully forward or a snug fitting rubber tube

is inserted. The lower end of this tube should have been previously tapered by cutting out a small triangle 6 mm wide and 15 mm long and suturing the cut edges of the altered tube as advocated by Mackenty. Drainage openings are now made in the skin flaps just above the clavicle and small rubber drains inserted. The trachea is anchored securely to the skin with heavy silk sutures to prevent retraction of the trachea. If the trachea is separated from the esophagus too far down, sloughing of the trachea will frequently occur and some tracheal rings may be lost. The remainder of the vertical and transverse incisions are closed with silk or metal skin clips. A No. 8 tracheal tube is now wound with petrolatum gauze near its outer end to make a conical close fitting plug and pushed gently into the trachea to form a leak proof cork. The tapes in the tube are tied around the neck. The inner tube is inserted, a gauze dressing applied over the incisions and drain wounds and a gauze apron taped in front of the tracheal tube to prevent aspiration of dust and to catch the expelled bronchial mucus when the patient coughs.

Variations of the above technic may be desirable at times. Von Gluck's curved lateral incision may be used as well as a broad skin and platysma flap with the base above or at either side. Babcock described a long transverse incision at the level of the hyoid bone and a short transverse one just above the suprasternal notch for the trachea. The two latter methods provide an excellent skin flap to place against the vertebral column to help form a new esophagus if the growth compels removal of its entire thickness. In such a case the flap ends would be cut later and turned with the skin inside to form the epithelial lined tube. Neither the lateral the straight midline nor Babcock's incision give as adequate exposure as Mackenty's or the broad flap incisions. Leaving the lower half of the cricoid cartilage gives a more patent tracheal opening but nearness of the growth usually prevents cutting that close to the carcinoma.

POSTOPERATIVE CARE

The after care of such patients is of very great importance. A well instructed nurse should be in constant attendance for several days. Suitable sedatives should be given to keep the patient quiet and comfortable. The air should be kept moist preferably with a steam kettle or tincture of benzoin compound vapor. The inner tube should be removed and cleansed as often as it collects mucus and then replaced. Sodium bicarbonate or 1 per cent caroid solution helps to loosen the coagulated mucus and facilitates cleaning this tube. An electric suction machine with catheter or a syringe and catheter should be available in the room at all times and used freely if mucus collects below the end of the inner tube. The outer tube should not be removed for several days except in case of almost total obstruction of the tube and then a curved forceps, nasal speculum or other means of widening the

tracheal opening should be kept in the patient's room together with a spare tracheal tube for immediate replacement.

Feedings are given through the nasal tube as soon as the patient can tolerate water without becoming nauseated.

The nasal tube should not be removed because its reinsertion is often difficult; it may upon reinsertion curl up in the pharynx or protrude through the sutured wound. I instruct my nurses to follow the following feeding tube routine: (1) Inject about 10 cc of water and



Fig. 409—Result of MacKenzie's T incision using an artificial larynx. The pad in contact with the tracheal opening is a half round rubber pad instead of a broad flat one and was designed by myself and the patient.

if it disappears more water may be instilled. (2) Give liquid food of high caloric and vitamin value such as strained fruit juices well sweetened or broth. (3) Give water to wash out any adherent food in the tube. (4) Now give 5 or 10 cc of a 1 per cent caroid solution to dissolve any food still adherent to the tube wall. Milk, thin gelatin and other suitable trained foods are added as soon as tolerated.

The patient can usually sit up in bed on the second postoperative day and in a chair on the next day.

COMPLICATIONS

Hemorrhage may occur and must be controlled by reopening the wound and ligating the bleeding vessel.

Failure of union of the pharyngeal suture line often occurs in about a week and permits saliva to drain into the wound and sometimes into

the trachea unless the outer tube is made water tight with a petrolatum gauze plug as before described

Infection of the wound occasionally follows and delays healing somewhat Adequate drainage is necessary

Sloughing and retraction of the trachea often tend to result in a stenotic opening after union has occurred and may require plastic widening of the tracheal orifice

If the outer tube is removed prematurely collapse of the tracheal orifice in individuals with fat short necks or in those with very loose flabby skin may prove fatal The outer tube should be left in place for a week or more and proper retractors and a spare tracheal tube must be ready in case a change becomes necessary

The patient is provided with a nasal speculum and a small mirror and shown how to spread the tracheal opening apart himself if necessary

Postoperative pneumonia usually follows carelessness in fitting the outer tube snugly into the trachea until all drainage has ceased

CONCLUSION

Laryngectomy is a perfectly rational method of treating cancer of the larynx With improvements in operative technic in the past decade we should expect an operative mortality of not more than 25 per cent in all cases so treated and can expect a 5 year or longer survival of 50 per cent of the patients surviving operation The patients who recover can be rehabilitated and readjusted readily to fill responsible positions in earning a livelihood

THE MODERN SUCCESSFUL TREATMENT OF BRONCHIOGENIC CARCINOMA

EVARTS A GRAHAM MD FACS

THE successful treatment of bronchiogenic carcinoma dates from April 1933¹ At that time a total pneumonectomy was performed because of the presence of a squamous cell carcinoma in the bronchus of the left upper lobe The patient a physician is well and carrying on an active practice eleven years later Bronchiogenic carcinoma is a condition peculiarly resistant to irradiation therapy and it is extremely doubtful if in a single authentic case a successful result has been achieved by this form of treatment In the absence therefore of any other successful method of treatment surgical extirpation seems to be the only recourse at present available which offers hope of a successful result Likewise a limited removal as by lobectomy seems to be as little successful as the limited removal of portions of other organs affected by cancer *Total pneumonectomy* has therefore become the commonly accepted therapeutic procedure of choice

TECHNIC OF TOTAL PNEUMONECTOMY

The operation is performed in one stage with careful dissection and individual treatment of the hilar structures At the Barnes Hospital, we prefer the posterolateral incision proposed by Crafoord with the removal of the fifth rib After freeing any adhesions which may be present a careful inspection and palpation of the lung is made particularly in the region of the hilus to determine whether or not the lung and all the tumor tissue can be safely removed If there is extensive infiltration of the mediastinum or of the chest wall or if the hilus is so extensively involved that a careful dissection of the vessels seems to be dangerous the attempt to perform a pneumonectomy is abandoned If however the conditions appear suitable for the removal of the lung the operation is continued in the following manner

On the right side the major azygos vein is isolated and divided between catgut ligatures Then the pulmonary ligament is dissected up to the inferior pulmonary vein Chiefly with finger dissection that vein is freed from its coverings The large vessels at the hilus are very short usually only about 2 cm in length and seldom more than 3 cm Those on the right side are shorter than the ones on the left and gen

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erally all these vessels are nearly as wide as they are long. The problem therefore of obtaining a secure ligation is more difficult than in the case of most other large vessels because at best one is left with a very short pedicle after the vessel has been divided. Our method of obviating the difficulty is as follows. A No. 2 catgut suture is tied as close as possible to the heart. Then with gentle traction on the tied suture away from the heart another similar ligature is passed and tied even closer to the heart. The two ligatures when tied are usually about 7 or 3 mm. apart. A long Ochsner clamp is then placed on the vein as close to the lung as possible even grasping lung tissue also in order to provide a maximum amount of distance between the clamp and the ligatures. In this way it is generally possible to obtain about 1 cm. of free vein. The vein is then cut across right at the clamp. This clamp remains in place during the remainder of the operation. After the vein has been divided a second Ochsner clamp is placed temporarily on the distal end of the vein which carries the ligatures and a transfixion suture of B silk is passed through the open end of the vein. This suture is tied completely around the end of the vein and the clamp is removed. In this way the end of the vessel is securely closed. The mediastinal pleura over the hilus is then slit open either by beginning at the distal end of the cut azygos vein or by lifting it up and dividing it immediately over the superior pulmonary vein. With gauze or finger dissection the pleura is gently pushed away to expose the latter vein. Generally in this way an index finger can be worked around and under the vessel to free it sufficiently to permit ligatures to be placed around it and tied in the same manner already described for the handling of the inferior pulmonary vein. In the same way also an Ochsner clamp is applied to the proximal end of the vein taking lung tissue in its grasp. The pulmonary artery which lies posterior to the vein is handled in an identical manner. In both cases it is desirable to dissect the vessels as close as possible to the heart in order to avoid the possibility of mistaking branches for the main trunks.

On the left side the procedure is the same as on the right except that there is not an azygos vein to deal with.

On either side after the vessels have been divided the only structure which holds the lung in the chest is the bronchus except for the bronchial artery and the divisions of the vagus nerve which form the bronchopulmonary plexus. Contrary to the opinion that has been expressed by others we have never found it necessary to block those nerve fibers by any local anesthetic drug before cutting them. We have never noticed any effect whatever on either the circulation or the respirations when those fibers were cut in a patient under general anesthesia.

The bronchus is dissected chiefly by the finger in much the same manner as that used in the dissection of the vessels. It is desirable however not to make the dissection too clean in order not to injure the

bronchial artery which is very important in the healing of the bronchial stump. For the same reason the bronchus should not be crushed with a tight clamp. In cases in which there is much purulent secretion it may be necessary to avoid contamination of the pleura to place a light clamp across the proximal part of the bronchus which however should only occlude and not crush the wall. Instead of using a clamp in some cases two long tenaculum forceps placed in the peribronchial tissue will often serve to prevent the proximal end from retracting and contaminating the pleura. As an extra precaution against such contamination it has been our custom for 10 years to pack the pleural cavity especially around the bronchus before it is cut with gauze saturated with neutral acriflavine (1 to 1000). The packing is removed after dividing the bronchus. Another precaution that is advisable is to close the bronchus with the fingers before cutting it in order to be sure that one is dealing only with a bronchus and not the trachea. In some patients with loose attachments it is very easy to pull down the trachea to such an extent that it can be mistaken for the bronchus. If the structure is pinched with the fingers during a few respirations it can be determined very easily whether or not an interference with the respiratory exchange has occurred. If not one can then be sure he is dealing with the bronchus rather than the trachea.

A satisfactory method of closure of the bronchial stump in my opinion has not yet been devised. We have tried every technic that has been described but still in certain cases the stump has reopened regardless of the method of closure used. It constitutes a serious complication when it occurs because an empyema follows as a necessary sequel. Our usual technic is to make an attempt to infold the wall of the bronchus by placing a series of B silk or cotton sutures through the peribronchial tissue. When these are tightened the bronchial wall is folded into the lumen. Reinforcing sutures of the same material are then applied in such a way as to make the closure more secure. This procedure is often facilitated by removing some of the cartilage. In some cases it is impossible to handle the stump in this manner and instead of the usual procedure three or four mattress sutures of silk or cotton are passed through the bronchus. After these are tied additional sutures of the same material are used to close the end of the stump. With either technic a flap of pleura is sometimes sutured across the stump. This flap may be either one that is pedicled or free. Occasionally there is enough mediastinal pleura available to make it possible to bury the stump in the mediastinum. This procedure gives great security but it is seldom possible of accomplishment. The right bronchus as a rule is more difficult to close securely than the left because it is larger and shorter.

After the bronchus has been sutured its closure is tested by pouring into the pleural cavity enough saline solution to cover the stump and bubbles are looked for.

A tight closure of the chest wall is made without drainage. The fluid which accumulates is allowed to remain undisturbed. Aspiration is performed only if there is reason to think that infection has taken place with the development of an empyema, or if so large an amount of fluid has formed as to cause dyspnea.

In my first case of total pneumonectomy it seemed to me that it would be desirable to perform a thoracoplasty in order to obliterate the large empty pleural space. Accordingly 7 ribs were removed at the time of the pneumonectomy and 3 weeks later 3 more ribs were removed. Rienhoff² however showed clearly that a thoracoplasty is not necessary and since his demonstration of that fact, we have omitted it except occasionally to assist in the healing of a chronic empyema that has developed as a complication of the failure of the bronchial stump to heal securely.

OPERATIVE MORTALITY

The mortality rate of the operation has declined greatly since the early years of its development. Blades, Poppe and myself have performed a total pneumonectomy in 112 cases.* Of these there were 98 operations for neoplasm and 24 for other conditions. This represents a period of 11 years. In the early years the technic was often faulty and the indications were not so sharply drawn as at present. I prefer therefore to concentrate on the results obtained since January 1, 1939, a period of slightly more than 3 years. During that time we have performed 83 total pneumonectomies of which 77 were for malignant neoplasm. In this group there were 23 hospital deaths, a mortality therefore of 27 per cent. Mortality figures expressed in this manner however are not so significant as they might seem. For example in our last consecutive series of 33 cases there were only 3 deaths, or a mortality of 14.8 per cent. One of these deaths was in a man, 70 years of age who died a week after operation in an attack of coronary thrombosis. Another patient died from the same cause 2 days after operation, and a third died presumably of heart failure from myocarditis 7 days after operation although there was no autopsy confirmation. I was led to operate on the 70 year-old man despite his age because of the remarkably uneventful convalescence which another patient, 68 years of age had had shortly before his operation.

If one wishes to select his cases more carefully the operative mortality will be still lower and may approximate zero but he will also deprive many patients of relief from their trouble. This is the dilemma in which the thoracic surgeon finds himself. Shall he offer a chance to the bad risk victim of bronchiogenic carcinoma even if it is only a small one to be cured of his otherwise hopeless condition or shall he decline to operate because of the great danger of an operative mor-

* Since this manuscript was submitted the number of pneumonectomies has grown from 11 to 123.

tality³ I think most of us will offer the patient a chance of recovery. After all an operative mortality of 14 per cent in 33 cases of malignant bronchiogenic tumor is a thoroughly respectable one and should dispel the all too common idea that the operation of total pneumonectomy for bronchiogenic carcinoma carries with it an enormous operative risk. It should be remembered that without operation the risk is 100 per cent.

CONTRAINDICATIONS TO TOTAL PNEUMONCTOMY

As indications for the operation it may be stated that a positive diagnosis based on a bronchoscopic biopsy constitutes an urgent necessity for a total pneumonectomy unless certain contraindications are present. These are as follows:

1 *The presence of bloody pleural fluid* Such a finding is almost certain evidence that at least the visceral pleura and probably also the parietal pleura has been invaded by the growth. When a pleural effusion of clear fluid is found it is nearly certain that at least the visceral pleura has been invaded although of course it is theoretically possible that the effusion has formed as a response to some other etiologic factor. Actually in the few cases in which I have performed a total pneumonectomy for carcinoma in the presence of a pleural effusion the patient has invariably died within a year of recurrence of the trouble.

2 *Paralysis of the corresponding half of the diaphragm* This finding readily determined by a fluoroscopic examination is evidence of an invasion of the phrenic nerve and in my experience precludes a successful result.

3 *Paralysis of the left vocal cord in cases of left sided bronchiogenic carcinoma* When this finding is present it usually denotes an invasion of the left recurrent laryngeal nerve as it passes under the arch of the aorta and it indicates that the growth is already so extensive as to preclude a successful operation. Exceptionally however the paralysis of the vocal cord may have a different explanation. For example I have had a recent experience in which I declined to operate on a man because of this finding but a few weeks later the cord had begun to move again a fact which gave evidence that its paralysis had not been due to invasion of the nerve. A total pneumonectomy was then successfully carried out with a reasonably good prospect of ultimate cure.

4 *Severe pain in the thoracic wall or down the arm* This is a bad sign and generally is evidence of an involvement of intercostal nerves or of the brachial plexus. The presence of a moderate amount of pain however should not by itself preclude an exploratory operation to investigate the possibility of a successful pneumonectomy.

5 *Bronchoscopic evidence of extension of the tumor into the tra*

chea will usually contraindicate pneumonectomy although occasionally it is possible to remove even a part of the wall of the trachea. Likewise firm fixation of the hilus as noted on bronchoscopic examination is an unfavorable sign but does not always indicate that pneumonectomy cannot be accomplished.

6 *The presence of distant metastases* as a rule will contraindicate the removal of the lung although in exceptional instances it may prove justifiable to remove both the lung and a solitary metastasis.

7 *The question of the age of the patient* is important from the standpoint of operability but at least up to the present time there is no fixed limit. The general condition and particularly that of the cardiovascular apparatus is more important than the chronological age. My oldest patient to survive the operation was 68 years of age. Another patient of 70 years made an immediately satisfactory recovery but died suddenly of coronary thrombosis 1 week later.

MANAGEMENT OF CASES IN WHICH DIAGNOSIS IS UNCERTAIN

Any discussion of the indications and contraindications for total pneumonectomy in bronchiogenic carcinoma is incomplete without some reference to the management of those cases in which although suspected the presence of the condition has not been established with certainty. A positive diagnosis can be made before operation best by bronchoscopic visualization of the lesion supported by a positive biopsy. Although others have occasionally been successful in establishing a diagnosis by use of a punch biopsy through the chest wall we have not found the procedure helpful. In those cases in which the growth has arisen in one of the smaller bronchi it is generally impossible to visualize the tumor through the bronchoscope. This is particularly true when the lesion is in an upper lobe. In our own experience it is possible to establish a positive diagnosis by bronchoscopic biopsy in only about 75 per cent of cases. The problem of what advice to give to the 25 per cent without a positive diagnosis is an important one. The answer in my opinion is generally fairly simple. If there is a reasonable suspicion of the presence of a carcinoma an exploratory thoracotomy should be performed without delay for in that way many lives will be saved. One of the most disheartening experiences which a thoracic surgeon has is seeing the large number of patients with hopelessly inoperable cancers. Too often the advice of the physician has been to wait to see if anything happens.

The clinical evidence after all is fairly trustworthy if the chief features are present. A chronic cough with the expectoration of blood streaked sputum in which tubercle bacilli are not found together with a hilar infiltrative lesion seen by x ray almost certainly indicate the presence of a bronchiogenic carcinoma especially if the patient is a male of middle age or more. These features are sufficient to justify

an exploratory operation regardless of the failure to see a tumor on bronchoscopic examination or of a failure to find a bronchial obstruction with lipiodol. In 17 cases of this kind in our experience pneumonectomy was performed and in 11 of the 12 carcinoma was found. In the other case the lung was removed although subsequent examination of it showed only the presence of a chronic inflammatory process.

TREATMENT OF MIXED TUMORS OF THE BRONCHUS (BRONCHIAL ADENOMAS)

One question of importance regarding the use of the operation of total pneumonectomy for new growths concerns the best method of treating that group of tumors usually termed bronchial adenoma. The controversy over this matter is due chiefly to a difference of opinion as to the nature and potentialities of this tumor. By many it is regarded as an essentially benign condition for which often only a limited resection of lung is indicated. Womack and I^{4, 5, 6} however regard it as a neoplasm which is always potentially malignant and very often malignant at the time of its first clinical recognition. For that reason therefore as well as because it is usually located in one of the larger bronchi we consider that the safest method of treatment in most cases is total pneumonectomy.

In the limited scope of this paper it would not be possible nor would it be appropriate to attempt to present convincingly the argument favoring the viewpoint of the essential malignancy of bronchial adenoma. Those who are interested may read our various papers on this subject. For the purposes of this paper it will perhaps be sufficient to state that when it assumes its malignant features it develops a marked tendency to invade neighboring structures and later to develop metastases in regional lymphatic glands and even in distant organs. In our opinion this tumor is the origin of most of those carcinomas other than the squamous cell variety which carry the common names of oat cell carcinoma, small round cell carcinomas, alveolar carcinoma, and many of the bronchial carcinomas designated as adenocarcinoma. A common feature of these tumors is their pleomorphism. Sections taken from different areas may present such varied appearances of structure that almost all the common names used by the orthodox pathologists could be applied to the same tumor depending upon what area of it was being examined. Cartilage and even bone are sometimes included. Because of their structural characteristics and their tendency to invade neighboring tissues we have recognized many similarities between these tumors and the common ones of the salivary glands. Accordingly we have preferred to call them mixed tumors of the bronchus instead of using the more conventional term of bronchial adenoma. We feel that our name is more expressive of the embryonic origin and of the most important characteristics of the tumor.

END RESULTS OF TOTAL PNEUMONECTOMY FOR BRONCHIOGENIC CARCINOMA

Since the title of this paper uses the words successful treatment it is desirable to give some statistics on the number of 5 year cures of bronchiogenic carcinoma obtained by total pneumonectomy. In our own experience we now have 5 patients who are well more than 5 years after their operation and 1 for more than 4 years. Three of these patients had squamous cell carcinomas and the other 3 had carcinomas of other types. The periods of survival are as follows: 11 years, 8 years and 5 months, 7 years, 6 years and 8 months, 5 years and 5 months, 4 years and 6 months. The possibility of a permanent cure of bronchiogenic carcinoma by the operation of total pneumonectomy seems therefore to be definitely established. The chief problem in the treatment of this condition today is the education of the medical profession in its early diagnosis and in persuading those who first see these patients to refer them promptly to competent thoracic surgeons. There is no justification for the widespread feeling of pessimism about the curability of bronchiogenic carcinoma.

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MALIGNANT TUMORS OF THE MALE BREAST

MORDANT E. PECK, M.D.*

BECAUSE tumors of the male breast occur with relative infrequency it has been difficult for any one individual to observe a sufficient number of cases to draw any adequate conclusions. This undoubtedly accounts for the variations in the opinions concerning the incidence, relative frequency and prognosis of these lesions. We recognize that the observations to be presented here are no exception. This paper will analyze the cases seen at the Barnard Hospital during the past 30 years.

There have been admitted to the Barnard Hospital during this period approximately 65,000 patients who were given the clinical diagnosis of neoplastic disease. Among these approximately 7500 breast tumors have been observed of which 1777 were verified by pathological study. Biopsy was not done in some cases in which the clinical diagnosis was obvious and operative therapy offered no hope of cure. These cases were treated by roentgen therapy. Of all the verified breast tumors seen at this hospital 43 were in males.

HISTORICAL DATA

The fact that cancer may occur in the male breast is referred to in the early medical literature. Gilbert stated that Franciscus Armentarius (1493-1573) refers to the fact that cancer may also occur in the male breast. The earliest reference that we have been able to meet with was that of Ambrose Pare (1510-1590) who states: "It (cancer) invades women more frequently than men and those parts which are lax, rare, fungous and glandulous and therefore apt to receive a defluxion of a gross humor such are the breasts and all the emunctories or noble parts." However, Fabricius Hildanus (1537-1619) was apparently the first to make a definite reference to carcinoma of the male breast when he described a single case. Subsequently an occasional report occurred in the literature until in 1883 Poirier undertook a more thorough investigation of the subject. In 1889 Williams reported on 100 cases which he had collected from various sources. Since numerous articles have appeared notable among them those of Wainwright, Neal, Gilbert, Sachs and Gechickter. Wainwright bases his study on a careful and exhaustive investigation of the literature and an analysis of the 264 cases reported along with 154 obtained by personal communication. Neal made a pathological investigation of 50 cases taken from autopsy findings. Gilbert analyzed the literature

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together with 47 cases observed at Memorial Hospital Sachs compiled 205 cases obtained from personal communications throughout the country and Geschickter in his recent book details 30 cases in the Johns Hopkins Hospital series

As stated previously at the Barnard Free Skin and Cancer Hospital during the past 30 years we have seen 43 tumors of the male breast among a total of 1722 verified cases of neoplastic disease of the breast Of these tumors of the male breast 15 were cancer This means that 25 per cent of all breast tumors in our series occurred in the male breast and that cancer of the male breast occurred in 0.87 per cent of the total of all male and female breast tumors in this series It is said that of 100 women having breast tumors 50 will have cancer whereas in men only one third will have cancer Our series is in conformity with this observation as 34.9 per cent of these male breast tumors were cancerous

ETIOLOGY

Heredity—There has been much discussion lately concerning the significance of heredity in the development of cancer Little and his co workers have recently obtained some very interesting experimental results by transferring the fertilized ovum of a low cancer bearing strain of mice to the uterus of a strain having a high incidence of cancer Subsequently the incidence of carcinoma increased in low cancer strains which had been treated in this manner Similarly the incidence of breast cancer increases in the offspring of a low cancer incidence strain nursed by a mother of a high cancer incidence strain This work would tend to show that certain factors may operate during pregnancy and lactation which influence the incidence of cancer in the offspring Williams is one of the few who has noted the family relationship in carcinoma of the male breast He found that of 29 cases in which the family history was recorded 7 (24 per cent) gave a history of cancer in other members of the family We found an adequate record of the family history in 12 of our 15 cases and of these 4 (33.3 per cent) gave a positive family history for cancer It is difficult to estimate whether these figures are of any significance Gilbert came to the conclusion that heredity is of secondary importance as a causative factor in male breast cancer We are inclined to believe that the full significance of heredity has not yet been accurately investigated It has been only in the last decade that any emphasis has been placed on the taking of the family history and even now many present records are inadequate in this respect

Age—The prevalence of carcinoma of the breast among the total population is in inverse proportion to age the mean age being around 60 years In 1914 the United States Census statistics showed the greatest number of cases to be between 50 and 55 years By 1940 the greatest number of cases was occurring between 60 and 64 years This is partially attributable to the greater number of people now living on

to the higher age groups in which cancer is more prevalent Ewin gives the youngest authentic case recorded in the female as being 17 years of age Blodgett reports a case of a boy 12 years old in whom the diagnosis of carcinoma of the breast was substantiated Census statistics generally record a few cases in which the patients were under 10 years but these are unreliable as they are not checked or verified

In our series of carcinomas of the male breast the youngest patient was 47 years old and the oldest 75 years The age distribution based on the crude figures was 59.5 years The significance of these figures rests only in their support of the fact that cancer of the male breast, like nearly all other cancer is a disease of the older age groups Its occur

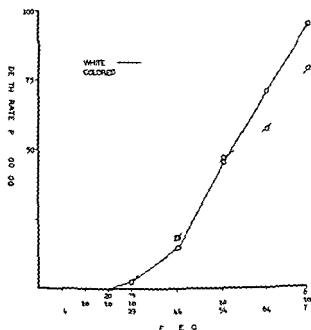


Fig. 410—Comparison of the breast cancer death rate per 100,000 of the white and colored populations (Metropolitan Life Insurance Company, 1931-1935)

rence apparently has no relation to sexual life since the age incidence steadily increases. It is to be emphasized that the age distribution based on the crude figures is of no value from either a statistical or etiological point of view. It would be impossible to calculate the age incidence of our group of cases as the patients did not come from any localized census area hence the number of people living at any one age group cannot be computed. One must therefore fall back on figures for the general population. The significance of the age ratio in contrast to the age incidence is illustrated by the graphs (Figs. 410 and 411) which are self explanatory.

Trauma—The significance of trauma as a causative factor in cancer

noma of the breast has been the subject of much controversy. Most authors seem to feel that it may well be a factor in male breast cancer but probably plays a minor role in cancer of the female breast. Gilbert attributes 79 per cent of his cases to probable trauma. Others do not report quite so high an incidence. However, Wainwright has found that the relationship occurs frequently enough to warrant its being taken into consideration as a cause of carcinoma at least in the male breast. Behan has investigated this subject rather thoroughly because of its medicolegal significance. He summarizes his opinions from a pathological standpoint. Fibrous tissue from minor forms of trauma may persist in the form of a scar. In later years an injury to the scar

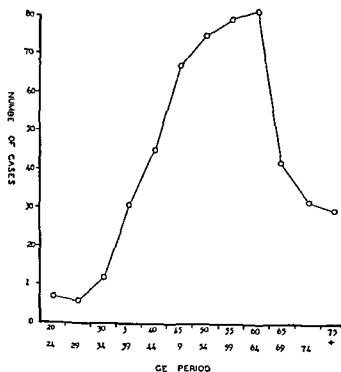


Fig 411—Age distribution of 520 cases of cancer of the male breast obtained from reports of Wainwright, Neal, Gilbert and the Barnard Hospital series.

may (when other and as yet undetermined factors are present) be sufficient to stimulate further abnormal productive tissue changes and thus lead to the formation of a cancer. He further says: In almost every case in which a trauma is to be regarded as causative of a cancer, it should have been so severe and the particulars of its character and the manner in which it was applied should have been so impressed upon the memory of the recipient that all the details of the injury can readily be recalled.

In our series 4 cases (26.7 per cent) gave a history of significant trauma. Only one of these cases gave a positive family history of cancer. There was a fifth case in which carcinoma followed 34 years after

superficial x ray therapy for eczema over the breast and chest wall. This patient also had a positive family history for cancer. We make mention of the family history in these cases because of its possible significance as a predisposing factor in the presence of trauma. Accurate evaluation of the importance of trauma is difficult to obtain because many histories are inadequate in this regard.

One case of ours does seem to have a definitely pointed relationship to trauma. Two years prior to admission in the clinic the patient fractured three ribs in an automobile accident. When the adhesive tape was removed 8 weeks later the patient noticed a lump in the left breast over the site of the fracture. This continued to grow, became painful and 8 months afterwards was diagnosed as cancer. He received a course of x ray therapy (5400 r) during which a hematoma of the breast was incised and drained. Subsequently the lump regressed but 10 weeks before coming to our clinic the lump reappeared. After our initial examination the patient was given a hospital appointment which he failed to keep. Hence it was not until 5 months later that a radical *mamnectomy* was carried out. The pathological diagnosis of adenocarcinoma was made and the patient died 4 months afterwards of a rapidly metastasizing carcinoma. It would seem that in certain instances a significant relationship does exist between trauma and cancer of the male breast, a relationship which one cannot entirely overlook.

Gynecomastia—Cheate and Cutler state: "The development of cancer in a breast which is the seat of gynecomastia is recorded but it is so rare that the event may be regarded as a coincidence rather than an example of etiological relationship." Gilbert, on the other hand, supports Ewing's contention that such hyperactivity and overdevelopment are factors predisposing to cancer in the male breast. He reports nine cases or 19 per cent of his series in which carcinoma developed in the presence of gynecomastia. In consequence he believes that the relationship between gynecomastia and cancer, although only occasionally mentioned in the literature, has not been sufficiently emphasized. We have not had in our cases any such relationship that could be considered definite. Occasionally we have observed a carcinoma to develop in the presence of chronic cystic mastitis in the female and feel that there is evidence to support the impression of many that this can be a precancerous lesion. However, the relationship in the male breast, although occurring, is apparently quite an unusual coincidence.

Multiple Carcinoma—The occurrence of multiple carcinoma is always of interest but its exact significance is difficult to evaluate. It occurred in one instance among our cases of carcinoma of the male breast. This man had at the same time developed a squamous cell carcinoma of the lower lip. Five weeks after the breast operation a V-excision of the lesion on the lip was carried out. There were 4 other cases among our entire series of male breast tumors in which primary carcinomatous lesions existed elsewhere. Two patients who had adeno-

fibromas of the breast also had squamous cell lesions of the lip and one of these required a suprahyoid neck dissection for metastatic spread. Another patient in the series had previously undergone a radical amputation for cancer of the penis. In 1 of our 2 cases of sarcoma in the male breast an associated carcinoma of the stomach was reported by another hospital but this was never verified by biopsy and the patient is still living.

CLINICAL FINDINGS

Symptoms—The symptoms of carcinoma of the male breast are such as one would expect from the nature of the lesion. Their *duration* is subject to some variation. Gilbert found the average to be 2.05 years



FIG. 412—Adenocarcinoma of the male breast

while Sachs found it to be 1.14 years. This latter figure corresponds closely with that found in our series in which the average was 1.15 years with the extremes ranging from 2 months to 3 years. We had one man who gave a history of a lump in the right breast which grew slowly in size from the time it was first noted 7 years previously. The seriousness of the lump was not recognized until 3 months before admission, at which time ulceration occurred. Four other patients gave a history of having had an asymptomatic lump for periods of 1 to 2 years before any evidence of growth occurred. Two of these cases gave a history of a lump disappearing only to return again with evidence of progressive growth. In all cases the initial symptom was the presence of a lump in the breast (Fig. 412). Seven patients had symptoms referable to the mass, but only 3 complained of painful sensa-

tions The other patients noted only a stinging burning or aching feeling

Physical Signs—All of our patients had a breast mass the size of which varied from 1 to 12 cm in the greatest diameter Nine patients had an ulceration of the skin over the site of this tumor Of the remaining cases without ulceration the tumor mass was fixed to the skin in 5 This means that ulceration was present or potentially present in all cases Only 1 case showed fixation to the deep tissues Speed has made the interesting observation in regard to these factors that the thinness of the pectoral fascia in the male allows the malignant cells to break easily through the fascia and invade the muscle via the lymphatics Consequently a breast cancer may appear to be freely movable on the underlying muscle and yet be involving it along these microscopic lymphatics

The side involved was nearly equal in this series 7 patients having carcinoma of the left and 8 of the right breast Sachs states that in the literature the left breast in most instances was found to be involved more frequently than the right From an etiologic standpoint it is interesting but undoubtedly only a coincidence that in all of our male patients with breast cancer in which trauma was considered as a possible factor the cancer occurred in the left breast

METASTASIS

In view of the small number of cases in our series the significance of any figures on the question of metastatic involvement must be guarded All except 3 or 80 per cent of our cases had clinical and pathologically verified axillary metastasis by the time they received treatment Of the 3 patients having no regional involvement 1 had a basosquamous cell carcinoma of the skin overlying the breast 1 died 5 months postoperatively of generalized metastasis and 1 died 5 weeks postoperatively of influenza complicated by nephritis In only 1 case were supraclavicular metastases found at the time of operation In 1 case a palliative simple mastectomy was done on a patient who was considered to have a metastasis to the lung at the time In 4 other cases metastasis to the lungs developed while the patients were under observation (6 months to 4 years 9 months postoperatively) Only 1 patient developed a recurrence to the skin There were no metastatic lesions to the bone among these cases as long as they were under our direct observation

The high incidence of regional metastases in this series nearly twice that reported by Sachs (46.34 per cent) and 2.5 times that reported by Neal (32 per cent) is difficult to attribute to any one simple factor Taylor and Nathanson observed that in the Massachusetts General Hospital 65 per cent of all patients with breast cancer on the public wards presented themselves with axillary metastases in contrast to 48 per cent of those patients who were entered on the private service

Moreover Eggers and his associates found that 76 per cent of all patients presenting ulcerated carcinomas of the breast had axillary node involvement. They also correlated the size of the lesion with the incidence of axillary metastasis finding for example that the percentage increased progressively from 25 per cent in the presence of a 1 cm lesion to 86.3 per cent in the presence of a 6 cm lesion.

If one applies these statistics as obtained from a study of female breast cancer to our male breast cases there is a significant correlation. All of our patients are ward cases whose symptoms before treatment averaged 1.13 years. The average size of the lesions when first seen was approximately 4 cm and 60 per cent of these had already ulcerated.

One must always consider that there is a marked variation in the percentage of axillary metastases as reported by different investigators. Warren and Tompkins in a careful study of 171 female cases in several Boston hospitals found the incidence to be 52.63 per cent whereas Geschickter found an incidence of 71.9 per cent in the series reported in his recent book. It is necessary to remember that variables such as the size of the lesion, ulceration, duration of the disease and also (not mentioned above) the grade of malignancy are factors which prevent adequate correlation between any two groups of reported statistics.

DIFFERENTIAL DIAGNOSIS

In general there should be little difficulty in the diagnosis of carcinoma of the male breast. One can always get a history of a growing nodule or a nodule which has recently appeared. The initial nontender mass is easily palpable because of the sparseness of breast tissue in the male. In the great majority of instances it will be fixed to the skin. If ulceration has occurred *sypilis* and *tuberculosis* must be excluded by the usual diagnostic methods for these diseases. *Paget's disease* must be thought of in the presence of ulceration although it is so extremely rare in the male breast that diagnosis should never be made except by microscopic study. Archibald in 1922 reported 1 proven case. Rubenstein made a search of the literature in 1930 finding 7 cases of which only 2 had been proved to be *Paget's disease* pathologically. Subsequently he added 1 case of his own. Sachs claims 2 cases in his series although it is uncertain as to whether the slides on these patients were reviewed. No cases were found in our series. Thus we know of only 4 definite cases that have been observed up to the present time in the male breast.

If there is no ulceration one must eliminate other causes of breast tumors in the male—*chronic cystic mastitis*, *adenofibroma*, *hemangioma*, *lipoma*, *sebaceous cyst* and *fibrosarcoma*. Moore reports the case of a breast tumor as due to a parasitic infestation with *Sparganum mansonii*. Clinically mastitis is the most frequent cause of male breast enlargement. It is characterized by a soft mass quite often tender to

palpation and occasionally associated with a discharge from the nipple. Also it occurs largely in the younger males (15 to 25 years) in which age group cancer of the breast is extremely unusual. As a rule however no sure diagnosis of a breast mass can be made until it is removed. Such a procedure should always be carried out. Then if the diagnosis is still uncertain in the gross frozen section biopsy can be made. Carcinoma of the male breast is an even more serious disease than in the female and no time should ever be lost in the expectant treatment of hope and observation. Such an attitude of procrastination has no place in the therapy of possible malignant disease.

PATHOLOGY

The microscopic appearance of carcinoma of the male breast does not differ from that of carcinoma in the female breast. There are two basic pathological lesions, i.e. those arising from the glandular ele-



Fig. 413—Adenocarcinoma of the male breast showing the microscopic characteristics of the scirrhous type of lesion. ($\times 85$)

ments—adenocarcinomas—and those arising from the nipple and skin overlying the breasts—epidermoid carcinomas. For all practical purposes there is no need to further differentiate these tumors since the important factor is the presence or absence of carcinoma. However from a morphological standpoint there is a further differentiation of these tumors which should be briefly discussed here.

Adenocarcinomas are generally subdivided into scirrhous, papillary, medullary (Figs. 413, 414, 415) and mucoid or gelatinous carcinoma. Scirrhous cancer is distinguished microscopically by its tendency to

form an excess of fibrous connective tissue enclosing tubular or acinar arrangements of the groups of cells. The latter may be largely lost in



Fig 414—Adenocarcinoma of the male breast showing the characteristics of the medullary type of lesion ($\times 85$)



Fig 415—Adenocarcinoma of the male breast showing the characteristics of the papillary type of lesion ($\times 85$)

very rapidly growing tumors but otherwise may form cords or islets which infiltrate the surrounding fibrous stroma. Medullary cancer on

the other hand is a more circumscribed growth in which there is only a semblance of acinar arrangement the cells appearing to be tightly corralled and growing in masses or herds. One gains the impression that the stroma in which the cancer is growing affects the differentiation into these two types. A dense fibrotic connective tissue stroma would tend to confine the tumor and produce a medullary carcinoma whereas a loose stroma would allow a more rapid outward infiltration of the malignant elements and produce a scirrhous carcinoma. Papillary carcinomas stand between the scirrhous and medullary types. They appear to grow in a papillary like manner within semi acinar structures but tend to be large and more or less circumscribed. Closely related is the mucoid carcinoma. Actually this is only a term given to a large slow growing acinar form (usually papillary) in which mucoid degeneration has occurred. The adenocarcinomas comprise approximately 90 per cent of the breast cancers. Geschickter states that of these the infiltrating lobular cancers which comprise 70 per cent in the female comprise only 50 per cent of cancers in the male breast.

The *epidermoid carcinomas* may be subdivided into Paget's disease squamous cell carcinoma basal cell carcinoma melanomas and the so-called sweat gland cancer. The latter is generally considered a rare tumor even in the female. It is said to be characterized by a yellowish color in the gross to have a low grade of malignancy and to arise in the axillary projection of the breast from the apocrine sweat glands. Paget's disease although likewise rare in the male should be mentioned because many male breast cancers could be easily misdiagnosed as being such a lesion. It has already been pointed out that this impression will rarely be substantiated pathologically. The diagnosis is dependent upon the presence of typical Paget's cells. These are large cells having a pale staining cytoplasm and a small deep staining nucleus always to be found at least in the epidermal layer of the nipple. Moreover we feel that this picture will almost never occur except in the presence of an underlying adenocarcinoma of the breast.

Squamous cell carcinoma basal cell carcinoma and melanomas need no discussion here as their characteristics are not peculiar to the breast. When they occur in the skin of this region they involve breast tissue only by secondary extension. Squamous cell growths very rarely if ever are primary in the breast itself.

We have in our series 8 scirrhous carcinomas 4 medullary carcinomas 1 papillary carcinoma and 1 basosquamous cell carcinoma. One patient had had a modified radical removal of the primary lesion before coming to us. The slide of the initial lesion was not immediately available for adequate classification but examination of an axillary lymph node from this patient revealed a medullary adenocarcinoma. However regional metastatic lesions are frequently medullary in character regardless of the nature of the primary growth.

We have made no attempt to grade any of the carcinomas in this series of male breast lesions. It may be stated however that of the adenocarcinomas the scirrhus type is generally the most malignant. The question of grading adenocarcinomas of the breast is a subject of divided opinion and need not be elaborated on in this discussion other than to say that microscopic grading of tumors is not generally practiced in The Barnard Hospital.

THERAPY

Our treatment of cancer of the male breast has been based upon the principles laid down by Halsted in 1894. In 17 of our 15 cases of male breast cancer a radical mastectomy was performed. (One of these operations was modified in that the fascia overlying the pectoralis but not the muscles themselves was removed along with the axillary contents.) Of the 3 remaining cases 1 had a simple mastectomy purely as a palliative procedure for removal of a large ulcerative lesion which we believed had already metastasized to the lung. 1 patient had undergone a simple mastectomy 2 weeks before coming to us and he refused further operative treatment. The patient with the basosquamous cell carcinoma was subjected only to a simple mastectomy because of the relatively slow growth of these lesions and the rarity with which they metastasize.

There are certain *criteria of operability* which must be considered before one can justly subject a patient to a major operative procedure. The aim of any operation for cancer is to save the life of the patient. If the operative risk is equal to or greater than the ultimate outcome of the pathological process the choice of therapy must be only palliative. Moreover if the operation of choice offers no hope at all for complete removal of the malignant process or for prolongation of the patient's life palliative therapy must be used. If there is even the slightest doubt as to the value of operation the patient should be given the benefit of radical therapy. Our criteria in male patients therefore have been two fold: first the general physical condition of the patient (cardiac status, presence of tuberculosis and so forth) and second the extent of the malignant process. The former should seldom be a factor as proper preoperative and supportive treatment combined with the proper choice and administration of anesthesia can considerably neutralize this risk. Regarding the latter definite supraclavicular or distant metastases (i.e. anywhere beyond the field included in a radical excision) contraindicate a radical procedure. The extent of axillary metastasis while influencing the prognosis has not at any time been an indication for palliative measures.

There are many factors which undoubtedly influence the success or failure of radical mastectomy as a curative procedure for cancer of the breast. It may be that the criteria for operability will become better defined as statistical analyses are carried out. Hagenston and

Stout have recently made such an analysis for female breast cancer. We find in reviewing their rule for judging operability that we might in the future consider these features as signs of inoperability in male breast cancer in addition to our present criteria: (1) extensive edema of the skin over the breast; (2) edema of the arm; (3) carcinoma of the inflammatory type; (4) the presence of any two or more of the following signs—ulceration of the skin, fixation of the tumor to the chest wall, axillary lymph nodes containing cancer (frozen section) which measure 2.5 cm. in their transverse diameter or which are fixed to the skin or deep structures of the axilla.

Roentgen therapy is an adjunct in the care of carcinoma of the breast, but it is not a substitute for operative procedures except in the cases requiring palliative treatment. Pack and Livingston state that the end results thus far reported no longer seem to justify the treatment of a patient with early primary breast cancer exclusively by the use of radium or roentgen rays (except in rapidly growing inflammatory cancers especially those observed during pregnancy and in young women) unless this patient has refused operation or because of some grave systemic disease is unfit to withstand a prolonged surgical procedure.

On the other hand radiation therapy does have a place as an adjunct to radical operation and that is *postoperatively*. Preoperatively there seems little justification for radiation since delay in operative therapy only prolongs the chance for metastatic growth. Moreover early irradiation may so limit the skin tolerance that postoperative therapy in the event of recurrence is inadequate. Only 2 of our patients were treated with radiation prior to operation. One received 5400 r 9 months before he came to us with a recurrence of growth in the initial lesion. Five months after we had performed a radical mastectomy this patient died of metastatic carcinoma. The second patient was at first considered inoperable because of supraclavicular metastases and was therefore treated with x ray as a palliative measure. Nineteen months later there seemed to be such good regression that a radical operation was performed. However the patient died of metastatic carcinoma 35 months later.

Pack and Livingston point out that a review of statistical reports in the literature on preoperative irradiation does not reveal any evidence of value in such therapy. Likewise statistical evidence does not support the value of postoperative radiation. Accordingly it has not been our custom to give routine radiation treatment to patients. In only 2 of our cases of male breast cancer was routine x ray therapy (postoperative) employed. One patient is living one year after operation, but has probable metastases to the opposite axilla. The second patient died 4 years postoperatively of metastatic carcinoma. Seven of our patients with male breast cancer were given heavy x ray therapy to recurrent and metastatic lesions discovered 4 months to 3½ years

later in the course of repeated postoperative examinations. These patients all had axillary metastases at the time of operation. The question then arises as to whether routine postoperative x-ray treatment to the axilla would have influenced the incidence of recurrence in these patients.

Recently Warren and Tompkins have analyzed a series of female breast cases in which radical mastectomy was performed without routine postoperative radiation. Eighty-five per cent of those patients having no axillary metastases were living and well 5 years postoperatively. On the other hand only 38 per cent of those with axillary metastases were living and well after 5 years. It would seem therefore that routine radiation to the axilla may be indicated in patients having regional metastases. Again however statistics do not support this contention. Harrington in a review of 3137 cases at the Mayo Clinic concluded: "Patients treated by radical surgical operation only and who presented axillary glandular metastases lived approximately 6 months longer than the group of cases treated by radical surgical operation and radiation." In view of the varied feelings on this matter of postoperative irradiation we feel it suitable to conclude with the statement Pack and Livingston make when they refuse to condemn the use of postoperative radiation. If these conclusions call more heavily on natural desire and hope than they do on analytical reasoning and measured experiences of the past there can be no question but that they possess almost irresistible weight.

END RESULTS

Statistics dealing with the prognosis of carcinoma of the male breast are somewhat confusing and certainly very distressing. Wainwright reported on 163 cases in which only 19 per cent of the patients survived 5 years. Gilbert had in his series 26 cases which had been observed for periods of 5 years or longer. Only 5 of his patients (19.2 per cent) were living at the end of the 5 year period. Geschickter reported that, of 25 patients adequately followed, 8 (32 per cent) lived 5 years. The only favorable report is that of Sachs who gives a 5 year survival rate of 47.8 per cent.

In view of this alarming mortality given in the majority of reports for treated cancer of the male breast it is necessary to compare the results with a series of untreated breast cancers. It has already been shown that the 5 year survival rate in untreated female breast cancer is about 70 per cent (Pack and Livingston). It would appear therefore that unless the reported cases of male breast cancer are free of the disease at the end of 5 years then the 5 year survival rate for treated male breast cancer is not much better than the survival rate for untreated female breast cancer. Wainwright was unable to make any over-all statement in regard to the 5 year cures in his cases of male breast cancer. It would appear from Gilbert's discussion that

only 3 patients (11.5 per cent) surviving 5 years were free from metastases (one patient died 1 year and another 2 years later of metastatic carcinoma). Geschickter likewise makes no definite differentiation between 5 year survivals and 5 year cures but it is stated that 5 of his patients died from recurrent carcinoma 6 to 7 years postoperatively. There is much confusion in the survival rates reported by Sachs but as far as we are able to determine only 7.5 per cent of his cases were free from metastases at the end of the 5 year period.

All of our 15 cases of male breast cancer have been adequately followed. We have had 1 postoperative death (6.7 per cent). Seven patients (46.7 per cent) have died of metastatic carcinoma all within 5 years. Two patients are now living with recurrent and metastatic carcinoma 15 and 30 months postoperatively. Two patients are living without signs of recurrence 7 months and 11 years postoperatively. Three patients died of intercurrent disease without evidence of a recurrence of their carcinomatous lesion one only a month postoperatively of the flu complicated by nephritis and a second 33 months postoperatively of pneumonia. The third is the only patient we have had with adenocarcinoma who survived 5 years. He died of myocarditis 61 months postoperatively. An analysis of our cases therefore reveals that there were only two 5 year cures. This represents a survival rate of 20 per cent excluding patients who died of causes other than carcinoma and also the 2 patients who are now living without recurrence but who were operated upon less than 5 years ago.

These results for treated carcinoma of the male breast are on first inspection far less favorable than those reported from operative therapy in carcinoma of the female breast. The latter are variously given by different clinics as being between 30 and 50 per cent for the 5 year survival. Among patients without axillary metastases the rate is approximately 70 per cent. However among those cases with axillary metastases the 5 year survival rate drops to approximately 25 per cent. Considering that all but 2 of our patients did have proven axillary involvement these figures do not differ widely from the results as reported for carcinoma of the female breast. Wainwright in his review of the literature states that *microscopic examination of the axillary glands is not mentioned often enough for analysis*. This is unfortunate for it would seem that the factor of axillary metastasis is definitely an important consideration in the poor 5 year survival rates for carcinoma of the male breast as reported in literature.

Generally therefore it would seem that the results of treatment of carcinoma of the male breast have not shown the progress revealed in more recent reports on the results of treatment for carcinoma of the female breast. This is probably attributable to five different factors: (1) the sparsity of breast tissue which in the male allows a more rapid local extension and regional spread of the malignant process; (2) failure of early recognition of the presence of a breast tumor by male

patients (3) the laxity with which male patients regard such small masses when they are first noticed (4) failure of the family doctor to recognize the serious potentialities of male breast tumors (5) failure of the family doctor to advise immediate investigation with the possibility of radical therapy if that treatment should prove to be indicated. The first three factors will be difficult to remedy because of the rarity of male breast cancer but if with increased information the patient's family doctor can recognize the lesion and advise proper therapy considerable progress will undoubtedly be made toward decreasing the present very high mortality from carcinoma of the male breast.

SARCOMA OF THE MALE BREAST

Malignant connective tissue tumors of the male breast are relatively common. It is variously reported that they comprise 2 to 5 per cent of all male breast neoplasms. We have at the Barnard Hospital seen 2 sarcomas of the male breast, thereby accounting for 4.8 per cent of all of our male breast tumors.

The *clinical history* as obtained from patients with sarcomas of the breast is not essentially different from that given by patients with carcinomas of the breast. There is however a very frequent relationship to previously existing benign breast tumors. Both of our cases gave such a history. One patient had noted a lump in the left breast for the past 17 years but it had only begun to grow 1 year previously. The second patient developed a pimple 3 years before admission which was located just medial to the left nipple and over the area from which a lymphangioma with hyperplasia of the epidermis had been excised 8 years previously. Three to 4 months before admission this pimple likewise began to grow. Pathologically both of these tumors were fibrosarcomas.

Examination of patients with sarcomas reveals that these breast lesions are generally large rapidly growing tumors which very seldom ulcerate. In 10 cases recorded by Neal none had ulcerated. Neither of our cases revealed any ulceration although 1 tumor measured 7 cm across. The remaining characteristics of these tumors do not distinguish them in any way from carcinoma.

The *pathological picture* of sarcomas is varied. Most authors report fibrosarcomas to be the most frequent in the male breast. Occasionally lymphosarcomas (Geschickter reports 3 from his 4 cases) myxosarcomas leiomyosarcomas rhabdomyosarcomas and liposarcomas have been observed.

The *treatment* of choice for sarcoma of the breast is a simple mastectomy. Sarcomas generally metastasize by the blood stream and hence axillary dissection is unnecessary. In the case of lymphosarcomas this therapy should be followed by radiation as these tumors are very radiosensitive and the axillary metastases associated with this type of sarcoma may be adequately handled in this manner.

The *end results* of treatment in our 2 cases of fibrosarcoma of the male breast have so far been favorable. In 1 a simple mastectomy was performed 9 years ago and the other a radical mastectomy (the preoperative diagnosis being carcinoma) 1 year ago. Both patients are alive and well today without evidence of recurrence. In the case of treated fibrosarcomas these results seem quite general. Geschickter states that the 1 case in his series was well 17 years postoperatively and quotes Connell's 1907 review in which 11 of 34 patients were considered cured. It would seem therefore that sarcomas of the male breast do not present the serious therapeutic problems encountered in the treatment of carcinoma of the male breast.

SUMMARY

An analytical review of 15 cases of carcinoma of the male breast seen and treated at the Barnard Hospital during the past 30 years discloses that these cases represent 0.87 per cent of all breast tumors (male and female) and 34.9 per cent of all male breast tumors observed.

These cases of cancer of the male breast have been studied in the light of reports found in the literature dealing with male breast cancer.

Radical operation in operable cancer is the only treatment offering any hope for cure. Our present criteria of operability are set down. Radiation therapy is an adjunct to radical operation but it is indicated routinely only in cases having proven axillary metastases at operation or in cases of inoperable carcinoma.

An analysis of the end results in our series reveals 5 year cures in only 20 per cent. The literature dealing with carcinoma of the male breast supports this very disappointing and challenging result. It is suggested that earlier recognition of all breast tumors by the local doctor with advocacy of immediate operative investigation and radical therapy in the event cancer is found might improve the general outcome.

The 2 cases of fibrosarcoma of the male breast in our series were briefly discussed. Simple mastectomy is advocated as the treatment choice for sarcoma of the male breast.

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ACUTELY OBSTRUCTING CARCINOMA OF THE COLON

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A MALIGNANT growth of the colon heretofore leading a more or less symptomless existence may suddenly provoke an acute abdominal emergency. This exigency will necessarily occur if the tumor either precipitates a complete obstruction or an acute peritonitis. The latter type of emergency is not under consideration in this paper.

Ordinarily symptoms develop gradually due to slowly progressive narrowing of the bowel lumen. They consist of crampy abdominal pains, borborygmus, distention and irregularity of bowel movements. Loss of appetite and weight and bloody discharge by rectum may further complete the textbook picture. In its atypical and less pronounced forms this syndrome may be difficult to distinguish from one occasioned by functional or infectious conditions like constipation, spastic colon, ulcerative colitis, chronic dysentery. Since a mass is not always palpable the final decision frequently depends on x-ray studies.

The accomplishments of the *x-ray technique* in demonstrating colonic lesions are indeed impressive so much so that we need to remind ourselves of the possibility of their occasional failure. We have seen, in many instances, that careful and repeated barium and barium air fillings of the colon failed to reveal abnormal bowel contour in patients harboring a growth which was later revealed at operation or autopsy. A second type of patient presents indefinite symptoms not arousing a suspicion either of malignancy or of colonic involvement. Such cases require in particular real alertness and a willingness to embark on involved and expensive diagnostic procedures on innumerable occasions without firm conviction regarding their necessity in order to avoid missing the rare positive case among the multitude of functional complainants.

Diagnostic uncertainty is greatly reduced if the patient has discovered a mass himself or if it is readily found by the physician. Palpable masses were recorded in older surveys as occurring in 40 per cent (Treves) and 50 per cent (von Mikulicz) of patients examined in a more recent survey from Johns Hopkins Hospital in 20 per cent (Miller). Palpability depends much on size and location of tumor. The large fungating carcinomas are more easily felt; the small scirrhous tumors hardly ever. Tumors of the cecum are the easiest to palpate; those of the splenic flexure most elusive.

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INCIDENCE

The term acute obstruction is somewhat inaccurate. In reality the word acute connotes merely the sudden development of a surgical emergency on the basis of long preexisting symptoms. In only a few instances it occurs quite suddenly, unheralded so to speak. It usually remains undetermined how the complete stoppage is brought about. It may not be said that the malignancy always obstructs the lumen so efficiently as to shut off the fecal current permanently. Too often there is a resolution of the obstruction after surgical decompression or even spontaneously. Other factors therefore have been considered contributory on the basis of actual observation or by mere conjecture: inflammatory edema, impaction of solidifying feces, kinking of the bowel at the tumor site, or fatigue of the intestinal musculature above the stenosis.

On the basis of the clinical history it should be easy to determine to which of the following three groups a given case of acute (complete) obstruction belongs: (1) Unheralded acute obstruction, (2) Acute obstruction superimposed on chronic obstruction, (3) Transitory acute obstruction (a) without significant symptoms before or since the attack, or (b) with significant symptoms before or since the attack.

While it is indeed surprising that a complete obstruction due to carcinoma of the colon can subside spontaneously, this possibility can be actually observed. If neither before nor following the attack the patient exhibits any characteristic findings such as a palpable mass or the annoyances of incomplete intestinal stenosis, the diagnosis may remain in doubt for quite some time. To illustrate the point and to prove how completely pervious the bowel can become a short time after the obstructive attack, the following case is briefly reviewed.

A 67 year old wiry man weighing 130 pounds complained of constipation of 2 months duration and cramps in the abdomen. Weight was unchanged. No blood or pus had been seen in the stool. The abdomen easily palpable seemed to be free of any masses and distention. He had large bilateral inguinal hernias descending halfway into the scrotum and containing intestinal loops. A gastro-intestinal x-ray examination was reported to be negative. Under the assumption that the hernias were responsible for his symptoms, a bilateral repair was done. The herniae were found to be of the direct type.

Three months after a most satisfactory postoperative course the patient felt nervous and vomited his food on two occasions. Abdominal examination showed hernia repair well maintained and nothing suspicious in the abdomen. There was a slight gain in weight after the operation. Five and a half months after the operation he suddenly became completely obstructed and was rushed to another hospital. After 4 days he had bowel movements again and felt so well that a gastro-intestinal x-ray series was made in order to locate the suspected malignancy. The barium enema was completely negative and the orally given barium showed only stasis pattern in the small intestines.

The patient was then transferred to our service and 2 very detailed gastro-intestinal series were made, one with a Miller Abbott tube in the ileum. No lesion nor any delay in the moving of the contrast medium could be found.

After two weeks of observation in the hospital exploration was decided on because of nightly pain in the left lumbar region and persistent occult blood in the stools. By this time there was a slight abdominal distention but defecation was readily induced with enemas. We found a very large tumor in the splenic flexure and a mass of equal size representing metastases in the preaortic lymph nodes. An anastomosis between transverse and descending colon was made and an appendectomy for decompression. The patient succumbed to peritonitis within 3 days probably on account of spillage during the operation. Autopsy was not permitted. A review of the preoperative x-ray plates by several roentgenologists still yielded a verdict of normal colon.

Either complete or incomplete obstruction ensues more frequently from tumors located in the distal half of the colon where the lumen is normally narrower and the contents less liquid. Furthermore lumen encircling and lumen shrinking tumors of the napkin ring type are more frequent in the descending and sigmoid colon conversely fungating polypoid and saucer shaped tumors with peripheral seat are more frequent in the proximal segments. Incomplete or complete obstruction may develop however from any tumor anywhere in the colon although there is an appreciable difference between the right and left half of the colon and between the eccentrically and concentrically growing tumors.

Complete stoppage of the intestinal flow occurred in 19 per cent of 128 colonic carcinomas recorded at the Johns Hopkins Hospital between 1893 and 1923 (Miller). In a collective statistical report from German hospitals (Reichel) the incidence was almost twice as high, 36.8 per cent (520 cases out of 1711). These figures include all cases of complete obstruction the vast majority becoming acutely obstructed after a preceding period of partial obstruction. Unheralded sudden obstruction occurred only 5 times (in 25 cases of acute obstruction) in the Johns Hopkins series and only 4 times in Reichel's own series which comprised 286 carcinomas with 144 complete obstructions.

In the following table quoted from Miller's analysis of the Johns Hopkins series tumor site and symptomatology are listed in juxtaposition. The data show at a glance the typical distribution of the tumors and the incidence of obstruction.

LOCATION OF TUMORS AND SYMPTOMS IN 128 CASES OF COLONIC CANCER
(MILLER)

Location of Tumor	No. of Cases	Complete Obstruction	Incomplete Obstruction	No Obstruction
Cecum	50 (38%)		24	24
Ascending colon	5 (4%)	1	1	3
Hepatic flexure	12 (9%)	2	6	4
Transverse flexure	7 (5%)	4	2	1
Splenic flexure	8 (6%)	2	3	3
Descending colon	6 (5%)	2	1	3
Sigmoid	40 (31%)	12	16	12

MECHANICAL PECULIARITIES OF LARGE BOWEL OBSTRUCTION AND THEIR CLINICAL SIGNIFICANCE

Prominence is at present given to the factor of *intestinal distention* and its consequences in the discussion of the pathology and pathologic physiology of bowel obstruction. Whenever intestinal contents accumulate the elastic gut immediately augments its holding capacity and accommodates ever increasing volumes. Thanks to the ease with which the intestinal wall stretches the intra enteric pressure rarely rises much above normal levels for any length of time but the stretching of the bowel wall eventually impairs its vitality and decreases its efficacy as a barrier between the bacteria infested contents of the intestinal canal and the sterile peritoneal cavity. Finally bacterial invasion occurs. In this manner distention contributes decisively according to a prevalent opinion to the fatal consequences of bowel obstruction.

The overdistended obstructed bowel is afforded some relief by backflow into the stomach and subsequent vomiting. *Duodenal intubation* accomplishes the same with better effect especially if suction is applied. The fact that some degree of suction is necessary in order to further the drainage demonstrates that in spite of tremendous overloading the intra enteric pressure in the obstructed bowel is not materially elevated. Relief by backflow into the stomach or by duodenal intubation becomes less effective if the obstructed loop is very long. If the obstruction is situated in the colon the intestinal segments closest to the obstruction will be benefited but little.

Added to the difficulty of retrograde drainage against unfavorable hydrostatic forces is the handicap of a check valve the *ileocecal valve*. If the valve functions with precision no overflow from the distended colon into the ileum is possible even when the former is at its bursting point. On the other hand the valve enables the small intestine to continue its peristalsis effectively with complete emptying and maintenance of normal lumen. Under these conditions the intestinal contents forced into the obstructed colon mount very rapidly. Wangenstein has likened the obstructed colon endowed with a persistently competent ileocecal valve to a closed loop. More descriptive seems to be a comparison with the pressure dome of a pump. It is in cases of this type where in contradistinction to small bowel obstruction markedly elevated intra enteric pressures do develop. The latter factor menaces the nutrition of the tissues already impaired by stretching. Therefore extensive necrosis or circumscribed perforations of the colon wall are threatening and actually account for most of the fatalities.

Incompetence of the ileocecal valve which in many cases occurs sooner or later with the increased filling of the cecum will avert extreme closed loop effect. The exceedingly precarious position of the colon in obstruction however is not entirely remedied if backflow is initiated. During obstruction the colon and particularly the cecum is

subjected to greater hydrostatic stress than the small intestines even with an unhampered communication between the two. The reason can be found in the fact that with equal intra enteric pressure prevailing in either the walls of the wider segment will be subjected to much greater stress than that of the narrower. Anschuetz (1902) demonstrated this with a model. Applied to the intestines as a whole this rule indicates that the colon is more distensible than the small intestines applied to the colon which may be regarded as a tube of unequal diameter at different levels (the cecum having normally a diameter twice the size of the descending colon) it readily explains why the cecum and ascending colon become so frequently the seat of the most conspicuous distention with the obstruction quite a distance for instance in the sigmoid.

We conclude from the foregoing analysis that obstruction of the colon by tumor although for all intents and purposes a mechanical block carries with it the implication of early damage to the bowel wall a damage which *pari passu* would occur in the small intestines considerably later. But in the colon hydrostatic and hydrodynamic forces act so as to accelerate greatly the accumulation of and distention by intestinal fluid and gas. With the integrity of the bowel wall jeopardized by extreme degrees of distention decompression becomes most urgent. The attitude of semiconservatism often appropriate for mechanical obstructions of the small intestine is out of place for these cases and surgical intervention must take place with the same promptness as if the vitality of the bowel wall were threatened by strangulation of its blood supply.

DIAGNOSIS

Recognition of complete obstruction of the large bowel by tumor is greatly facilitated if a period of chronic incomplete obstruction precedes the attack. The history will then directly point toward the source of the trouble.

History—In unheralded suddenly developing obstructions the history is scant. The patient might have some vague recollection of abdominal cramps or occasional blood in the stools but only yesterday or a few days ago did he really become perturbed by sharp abdominal cramps inability to move his bowels and distention. He probably tried a cathartic which he vomited. Then he turned to enemas and possibly attained some results but in spite of the apparent success the distention continued while the pain became more persistent. If the obstruction has not existed very long he still will be ambulatory and will look surprisingly well. He frequently accepts with obvious disbelief the verdict that hospitalization and treatment are urgent.

Physical Examination—The characteristic physical finding is the *marked abdominal distention*. With careful percussion it may be possible to outline a meteorism which corresponds to the location of the

colon. The cecal region in particular should be investigated. *Meteorism* does not develop to a comparable degree unless the stoppage of the intestinal transport is also complete for gas. In chronic obstruction the colon may become greatly dilated by the accumulation of feces yet the abdomen has not the drumlike appearance as long as the intra-enteric pressure due to the escape of gas remains within bounds (Figs 416 and 417). *Tenderness* and *rebound pain* are present to some degree but will become pronounced if the intestinal wall has become

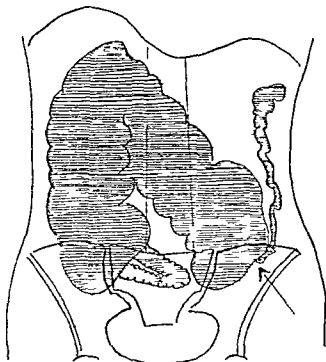


Fig. 416 (Case C. G.)—Skiagram of preoperative x ray picture (recumbent position). Incomplete obstruction of the transverse colon. Outlined by barium inadvertently given orally the colon appears enlarged up to the stenosis at ↑. There was no gas visible. The barium shadow remained for days unchanged in size only losing gradually some of its density. The patient expelled some stool and some gas and was never severely distended. When cecostomy was performed the ascending colon was found to be large filled with liquid feces but not under tension.

inflamed. *Visible peristalsis* is unusual in acute colon obstruction and has not been observed in our cases. This phenomenon is rather a feature of compensatory effort during the phase of incomplete obstruction. In complete obstruction the great distention renders the muscularis ineffectual; therefore colics and borborygmus soon subside. The distention will likewise make it virtually impossible in most cases to palpate the tumor mass unless it can be reached by vagina or rectum.

Examination of Stomach Contents—Next to recognition of the meteorism it is very important to get full information about the stomach

contents. We expect in colonic obstruction in contradistinction to small bowel obstruction and obstruction at the ileocecal valve which might develop in some carcinomas of the cecum a clear stomach contents or one containing only recently swallowed ingesta. At least, as long as the ileocecal valve protects the small intestine from the cecal overflow vomiting is merely a reflex from intraperitoneal irritation. In any event and in keeping with the rules pertaining to the management of bowel obstruction the stomach has to be aspirated even if the patient has not suffered from nausea or vomiting. Some patients will tolerate intestinal backflow so called fecal content in their stom-



Fig. 417 (Case C. G.)—Acutely obstructing carcinoma of the colon. Surgical specimen of resected part of transverse colon. Two weeks after decompression the lumen proximal and distal to the obstruction was still very unequal. This was mostly due to the narrowing of the distal loop forming distal. The proximal loop was no longer distended. The stenosis created by the small constricting intramural tumor was fistulized. The stenosis could barely be passed by a fine wire probe. Yet there was no complete obstruction. The polypoid changing the distal orifice of the stenosis channel acted as an efficient ledge against the backflow of rectal contents toward the cecostomy.

ach for days whereas others who had clear vomitus before may have intestinal regurgitation by the time they enter the hospital. If the stomach tube evacuates nothing but gastric contents the diagnosis of large bowel obstruction is greatly strengthened if feculent material is aspirated the diagnosis is more in doubt. The backflow may be due to obstruction in the small intestines or due to their participation in a dilatation and stasis ascending from the point of obstruction in the colon or finally due to a supervening peritonitis. If the stomach contents was abundant or fecal or if immediate surgery is contemplated the nasal tube is left in place.

X-ray Examination—Whenever possible the diagnosis should be fur-

ther elaborated by a *scout film* of the abdomen. One may prepare the patient with a preliminary enema of small volume for instance 6 ounces of magnesium sulfate or a glycerine mixture however this is not permissible if the slightest suspicion of peritonitis exists. The enema should not be repeated if the patient was subjected to this procedure just a short time before. Suppose the enema is given and a bowel movement is obtained. This may change the situation materially. If there is definite relief further observation and other attempts of opening the blocked bowel are permissible. If there is stool and passage

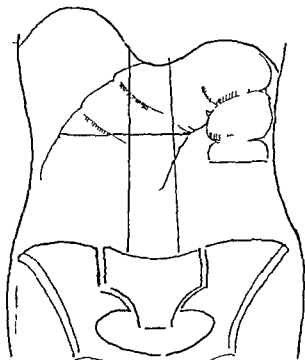


Fig 418 (Case A B) —Skigram of x ray picture (standing position) Complete obstruction of transverse colon. Acute onset with severe distention. No intestinal backflow. Ileocecal valve competent. Emergency cecostomy for decompression of an enormously dilated and very tense ascending colon. Small intestines practically empty. The tumor was subsequently found in the left half of the transverse colon. What seems to be the splenic flexure in the picture probably was the right half of the transverse colon stretching way over to the left.

of gas but no definite improvement of distention and lessening of pain or discomfort the emergency continues unabated and the only accomplishment is a more or less effective evacuation of the bowel below the obstruction which will facilitate the x ray examination to some extent but will not relieve the obstruction one iota. This bears emphasis because one may be easily deceived in considering the evacuation as proof of the absence of obstruction or at least as indication that it is relenting. Only if marked subjective and objective relief is demonstrated is such a conclusion permissible.

Concerning the *technic and interpretation* of the x ray films we must refer to the roentgenologic literature. We merely wish to point out that the diagnosis of bowel obstruction and its localization are immeasurably helped by the roentgenographic visualization of the gas distended loops. In some cases huge accumulations of air found exclusively in loops identifiable as colon loops made the diagnosis practically certain. If distended and air containing loops suggestive of small intes-

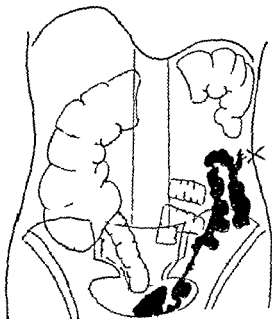


Fig. 419 (Case W. D.)—Skyscreen of x ray picture (reunbent position). Complete obstruction of transverse colon. Acute onset with severe distention, no chronic obstructive symptoms preceding. No intestinal labile flow. X ray seems to show gas distended colon including the splenic flexure. Gas in several loops of small intestine indicate incompetence of ileocecal valve. A perforation in the standing position demonstrated numerous fluid levels not seen in this posture. The ileum enema topped at A. The tumor is therefore suspected in the center of the descending colon. Emergency colectomy for distal compression of a very tense colon. Subsequent radical peritonitis. Tumor as found in the middle of the transverse colon. It is possible that what appeared to be gas-filled splenic flexure was actually the elongated right half of the transverse colon stretching far beyond the middle.

tainies show up in addition one must consider the possibility of a peritonitis. If no colon loops are outlined on the film the diagnosis of large bowel obstruction is improbable (Figs. 418 and 419).

Use of Barium Enema—In addition to the information gleaned from the flat or open film we have another means to check the diagnosis and moreover to locate the exact spot of the obstruction in the barium enema. In the presence of obstruction however it is mandatory that

the rectal filling be done cautiously. In the routine examinations of the colon delays in the progression of the barium column are overcome by kneading through the abdominal wall and by elevating the enema can. One must refrain in cases of obstruction however from too forceful manipulation of the colon under the fluorescent screen. The entry of barium into the obstructed loop may be the straw that breaks the camel's back because a perforation of the distended loop barely covered by a veil of serosa or an adhesion may thus become unsealed. It is of course understandable that the practice of caution may lead to misinterpreting a spasm of the colon below the growth as the actual site of the growth. It ought to be superfluous to mention that barium by mouth is strictly taboo in all cases of suspected obstruction.

Differential Diagnosis—After x ray studies have confirmed the diagnosis of large bowel obstruction and localized the site of the growth the cause of the obstruction still remains to be determined. In the obstructions supervening after chronic stenosis the history is usually a reliable guide to the specific diagnosis of obstruction by tumor. In the unheralded sudden obstructions differentiation from *volvulus* (mostly of the sigmoid or cecum) and from *spastic ileus of the colon* is of practical importance. In *volvulus* a limited procedure like the contemplated surgical decompression might be insufficient to avert disaster while in *spastic ileus* it may be superfluous because relief may sometimes be obtained from spinal anesthesia alone. The roentgenologist may find indications for the diagnosis of *volvulus* in the form of elongated and abnormally located colonic loops. *Spastic ileus* of the colon on the other hand is roentgenologically more or less indistinguishable from tumor obstruction.

Summary—In resume the diagnosis of large bowel obstruction is based on the following items: (1) Stoppage of spontaneous bowel movements and of flatus associated with cramping pain. (2) Extensive meteorism possibly outlining the cecum and ascending colon. (3) Absence or delayed appearance of intestinal backflow into the stomach in spite of a general picture of bowel obstruction. (4) X ray visualization of large distended colon loops especially with no gas accumulation in the loops of the small intestines. (5) Block in the colon demonstrated by the barium enema.

The diagnosis of tumor as the cause of the obstruction is based on circumstantial evidence and requires verification.

TREATMENT

The general condition of a patient with complete obstruction of the large bowel is naturally compromised if he is suffering from tumor cachexia or from the effects of a preceding severe chronic bowel stenosis. The recent occurrence of the complete stoppage in itself does not produce initially at least shock symptoms or dehydration because

the great quantities of intestinal secretions are not lost by vomiting and can reenter in a fair measure into the portal circulation through absorption by the more or less unaffected lower ileum. Nor are there any conspicuous plasma losses from capillary leakage as long as no further complications have developed.

In any event *preoperative rehabilitation* plays a lesser role in large than in small bowel obstruction. Since the relief of the distention is so urgent, complex attempts to rectify anemia, hypoproteinemia or dehydration have to be deferred. In planning treatment one should always keep in mind that perforation looms as a potentially fatal complication in patients who are still ambulatory. Reichel stated that in his personal experience patients unrelieved of complete colonic obstruction succumbed as early as 2 days and not later than 8 days after its onset.

The *preoperative preparations* should be therefore brief and immediately effective. We enumerate (1) decompression of stomach and its continuous drainage thereafter, (2) preoperative sedation in accordance with the type of anesthesia selected, (3) sufficient glucose and if indicated plasma to support the patient during a laparotomy of limited scope and short duration.

The objective of the surgical intervention is strictly limited; its sole purpose is to secure decompression.

Since the advent of the Miller Abbott tube, successful intubations through the full length of the small intestines and into the colon have been accomplished on numerous occasions. It is not impossible that occasionally the colon could be decompressed in this manner sufficiently to release the obstruction. Knowing the difficulties and delays in passing a tube through the small intestines, we reserve such attempts for cases where operation is refused by the patient.

The *surgical procedure* has to be carried out with utmost expedition and caution and with avoidance of two well recognized hazards, namely, (1) postoperative shock to which the obstructed patient shows an increased susceptibility, and (2) postoperative peritonitis, which might spring up from a distended loop handled too much during the operation. It is therefore generally agreed that extensive surgery in the face of complete obstruction is not only contraindicated but must be regarded as a transgression. This wisdom has been painfully acquired at an earlier stage of surgical experience when intestinal resections were done without discrimination. In the presence of acute obstruction such undertakings were followed by a mortality so prohibitive that one can only say that a patient survived the operation once in a while. Finsterer more recently lost 4 out of 5 patients with obstruction and became thereafter an advocate of multi-stage operations in these cases. It made slight difference whether the supposed safer exteriorization procedure (after Bloch-Paul Mikulicz) was tried or resection with immediate suture anastomosis. Mikulicz who con-

tributed so splendidly to the rationalization of colon surgery warned as far back as 1902 against the use of his operation in obstructed cases

Concerning the *choice of anesthesia* there are no valid reasons to advocate any special technic exclusively. We are however reluctant to subject any patient to a general anesthesia who has intestinal back flow notwithstanding the apparent safeguard of the nasal tube

Surgical Treatment—First Stage—The surgical decompression of the colon may be attained by various types of enterostomies appendicostomy tube cecostomy cecostomy with lateral opening cecostomy of the loop type also loop colostomies and lateral colostomies in other segments of the colon finally ileostomy with a catheter introduced



Fig 420—A Lateral cecostomy lateral sigmoidostomy drainage of cecum through catheter introduced into the terminal ileum B Appendicostomy tube cecostomy double barrelled colostomy of ascending colon and transverse colon There are still more possibilities Our preference is for lateral cecostomy

through the ileocecal valve into the cecum has been used (Fig 420 A and B) All these procedures have their merits and demerits and personal preference is allowed a certain latitude Only one procedure is definitely prohibited namely short circuiting entero anastomosis This operation puts the patient with complete obstruction in the same jeopardy as does a resection of the bowel

Our preference has been for the *lateral cecostomy* This method permits an aseptic operation without mobilization of the bowel and therefore practically without handling At the same time the opening can be made large enough to assure an abundant drainage with little chance for by pass of the fecal stream It does not close spontaneously

as does a cecostomy with a tube buried in a Witzel channel or an appendicostomy but we do not feel that the closure of the cecostomy by operation constitutes a greater risk than pulling out the tube. The incision is a short one between $2\frac{1}{2}$ and $3\frac{1}{2}$ inches according to the thickness of the panniculus. It is placed over McBurney's point and in the same direction as for appendectomy. No special attempt is made to accomplish an exact muscle splitting dissection of the abdominal layers. On opening the peritoneal cavity attention is paid to the amount and quality of the peritoneal fluid.

A knuckle of the anterior cecal wall is made to protrude through the incision and is anchored to the skin edges with mattress sutures of No. 00 catgut on atraumatic needles. The sutures are first passed through the skin then through the serosa of the cecal wall at right angle to the first direction and back again through the skin. The anchorage to the skin is simpler than the older procedure of suturing the peritoneum first to the edges of the skin incision and then fastening the cecal wall to the peritoneum. Both methods seek to protect the subcutaneous and fascial layers from the contact in the feces. We avoid any suture penetration into the lumen and intentionally no communication is established for several hours—a minimum of 6 hours is desirable—before the cecum is punctured for the release of gas. In very precarious cases where patches of infarction appear in the cecal wall it will become necessary to aspirate immediately. If a fine hollow needle is used spillage should be so small as to remain without consequences; the puncture ought to be self sealing following the deflation of the bowel.

Where exploration seems to be necessary because volvulus is suspected or a previous abdominal operation suggests that the obstruction could be due to adhesion in which case severance of a band would likely redress the precarious situation in its entirety the short McBurney incision does not serve the purpose. We have used either a subumbilical midline or preferably a pararectal incision just long enough to permit the introduction of one hand. During such exploration we have occasionally observed the startling picture of completely collapsed small intestines up to the ileocecal junction and a cecum of such enormous diameter and tenseness that we had difficulty convincing ourselves that the distended organ was not a large cyst. In the presence of great distention the closure of the incision has been at times difficult. We have not resorted to preliminary deflation of the colon by needle aspiration; instead we have used the anterior cecal wall as a patch inserted into the gaping peritoneal wound. By thus sewing the cecal wall to either edge of the peritoneal incision tensionless closure of the abdominal cavity may be accomplished. The outer layers of the abdominal wall are then sutured only at the corners and iodoform packs are placed against the cut edges of muscles and fat. If the cecal wall cannot be advantageously inserted into a midline incision which is

under precarious tension it might become advisable to approach the cecum through a separate incision of the McBurney type and complete the cecostomy first. After immediate needle aspiration the intraperitoneal pressure should be sufficiently reduced as to permit a reasonable closure of the first incision.

The wound dressing of the completely closed separate laparotomy incision is simplified by sealing a square of gauze under broad strips of overlapping adhesive plaster applied in the longitudinal direction. The cecostomy wound has a separate gauze dressing which is secured in place so as to permit frequent changes without interference with the clean laparotomy wound.

Surgical Treatment—The Interval—The recovery is prolonged or perforation and peritonitis might still ensue if the bowel was decompressed too late. Usually the recovery from the cecostomy is very prompt. Some of our patients with small incisions are encouraged to get out of bed on the fourth day. Decompression of the bowel is begun as mentioned before 6 hours after the operation or even later in order to give the wound an opportunity to adhere before the stream of feces begins to roll out. Insertion of tubes into the exposed knuckle of cecum has often been of no help in avoiding soiling. In most cases the feces became too thick for the tube and the latter had to be removed for adequate evacuation. These observations make us believe that tube colostomies are not ideal for emptying an obstructed colon. For the protection of the surrounding skin and if present of a second laparotomy wound metallic aluminum powder is dusted on skin and dressings. The functioning cecostomy is covered with a few layers of gauze changed as often as necessary or if the discharge is copious and liquid left uncovered under a cradle for the bed covers. Frequent change of dressings or a constant mopping up of liquid discharges together with a good aluminum coating avoids painful excoriation of the skin.

When the cecostomy wound is well sealed the incision in the bowel wall is enlarged and *irrigations of the ascending colon* are begun in order to clean the obstructed segment. With the stoma as wide as possible very little if any new intestinal contents will enter the obstructed loop.

The intestinal stream coming through the ileocecal valve becomes semisolid sooner in some patients than in others. If the appearance of semisolid feces is delayed special care is necessary. Not only is skin irritation more difficult to prevent in these cases but the patient's nutrition may become precarious. We feel more reassured about the comeback of a patient if his cecostomy discharges semisolid feces. In this event we do not hesitate to let him recover at home as soon as he has learned to get along with his stoma. On the other hand when the intestinal discharges are copious and liquid constant nursing care is needed. The diet in either case should be low in residue and high in

protein and carbohydrate content. For the *diarrhetic patient* the whole gamut of constipating foods and drugs are usually tried but often found wanting. A threatening depletion and liver damage should be recognized early by the determination of the blood levels for sodium chloride, protein and amylase, and if so indicated the oral feedings must be supplemented with parenteral glucose, sodium chloride, amino acid, vitamins, plasma and blood infusions. If it becomes evident that the maintenance of the nutrition presents a problem due to loss through the cecostomy, the date for the second operation should be set as early as possible and the cecostomy closed at the same time.

The usual time allotted for the reconditioning of the blocked bowel is between 2 and 4 weeks. During this period the stagnant feces can usually be removed and the bowel can regain its normal tone. Difficulties in this respect are encountered occasionally where the feces are solid or impacted as may happen in some instances of preceding chronic (partial) obstruction. There may be veritable enteroliths, or more commonly, doughy masses sticking tenaciously in spite of many irrigations. Since in most cases the obstruction becomes patent again after decompression, we suspect persistent fecal impaction at the tumor site if rectally given enemas do not eventually drain retrograde through the cecostomy.

In order to assure complete evacuation some surgeons place the enterostomy not in the cecum but immediately proximal to the stenosis. This stoma is later on removed together with the tumor during the second operation. While it is true that stomas so placed give the advantage of improved bowel drainage, they cannot be planned properly without abdominal exploration because the localization of the obstruction by barium enema may be misleading. Moreover, the removal of the colostomy coincidental with the bowel resection renders the asepsis of the major procedure questionable.

Surgical Treatment—Second Stage—With a rehabilitated patient and a well cleaned out loop the major procedure can be undertaken with confidence. There are no reasons to believe that resectability and curability are diminished in a series of acutely obstructed cases as compared with uncomplicated cases of colonic malignancy. As a matter of fact, the prior establishment of the enterostomy adds to the safety of the radical procedure and a three stage procedure—cecostomy, bowel resection, closure of cecostomy—is in some clinics the procedure of choice even for nonobstructing lesions.

The special surgical technique recommended for the major task of resecting the cancer bearing bowel do not need to be reiterated here. With a preceding cecostomy, defunctionalizing the colon, a suture anastomosis can be done with greater frequency and safety. We believe that *end to end anastomosis* is the ideal procedure whenever technical skill and favorable anatomical conditions permit its application. By favorable anatomical conditions we mean a free mesentery.

a complete serosal investment of the bowel and a minimum of fatty appendages. These criteria exclude the ascending and descending colon. For the former the total excision of the right half of the colon is the standard procedure; for the latter the exteriorization resection with subsequent spur crushing and closure (Paul Bloch Mikulicz). The suture anastomosis will be given consideration mostly for tumors in the transverse colon and in the sigmoid. Whenever the preoperative preparation is unsuccessful in emptying the colon completely, suture anastomosis is unsafe in any part of the colon.

In the event that the cancer involves adjacent structures too extensively for a radical removal but a longer survival of the patient seems likely, *short circuiting operations* may offer worthwhile palliation. Ileocolostomy or a colocolostomy should be selected according to the site of the tumor and with the view in mind to leave the by-passed segment as short as feasible in order to minimize fecal stagnation in the excluded loop. If the lesion is locally operable but minimal metastases are discovered in nonremovable lymph nodes or in the liver, one may on occasions carry out the radical procedure as the best means to provide comfort and simplify nursing care.

Surgical Treatment—The Closure of the Cecostomy—The incentive for doing this operation at an early time is the desire entertained by patient and physician alike to have the tedious treatment completed and be rid of the unpleasantness of the artificial anus. Unless the patient is losing ground from the excessive discharge of unabsorbed nutritional intake as happens in some cases, a certain restraint is advisable. Locally the cecostomy wound should be well healed without any pockets in the subcutaneous tissue. Its scar tissue should be firm without undue induration and the skin free of excoriations. There should furthermore be no suspicion about the status of the anastomosis; even an infection apparently limited to the laparotomy wound can have a fistulous connection with the former. Patency of the anastomosis should be demonstrated by barium enema. If all these factors have been considered, postponement of the closure may still be in order in cases which are suspected of early local recurrence at the site of the resection. A follow-up with more barium enemas might finally settle the issue.

In preparing the patient for this minor operation the diet should be restricted to liquids for 2 days and it may be useful to give a sufficient dose of sulfasuxidine to render the feces relatively abacterial and less bulky.

SUMMARY

1. One in every 5 or even 1 in every 3 patients with carcinoma of the large bowel (rectum and rectosigmoid excluded) suffers an attack of complete (acute) obstruction.
2. In most cases the complete obstruction occurs after symptoms of intestinal stenosis are present for some time. In a few cases the complete obstruction is practically the initial symptom.

3 Patients with complete obstruction of the colon develop rapidly a severe meteorism which endangers the viability of the colon and especially of the cecum

4 The hydrostatic and hydrodynamic factors responsible for the building up of abnormal enteric pressure in the blocked colon are discussed and the precarious role of the cecum explained

5 Decompression is urgent to prevent perforation or gangrene of the colon. The decompression can be effected with certainty only by some type of colostomy preferably by a lateral cecostomy

6 More extensive surgery of the obstructed bowel is contra-indicated

7 Following decompression of the obstructed colon resection of the tumor bearing segment can be carried out safely and with a curability rate comparable to those not complicated by complete obstruction

8 Technical details for the making and closing of lateral cecostomies are given

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ADENOMA OF THE RECTUM

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THE term adenoma of the rectum is used to designate those localized overgrowths of glandular epithelium that project into the lumen of the bowel with no evidence of invasion into the rectal wall. The cells are often well differentiated and tend to resemble the normal rectal mucous membrane. These lesions may occur at all ages. When they are seen in children as they often are they usually are attached to the rectum by a long slender pedicle which expands distally giving a clublike appearance. In children such lesions are generally found low in the rectum and surgical extirpation by simple excision of the base is readily carried out. In the young they are also noteworthy for their benignancy. In the adult however adenomas of the rectum present an entirely different problem namely that of malignancy. This problem may assume great importance. Because of the tendency of these tumors to become malignant the surgeon must decide whether or not such a change has occurred. If malignancy can be established he must next be confident that after treatment all of the lesion has been removed or destroyed.

PATHOLOGY

Microscopic—A so called adenoma is composed of cells that tend to produce mucus. They are for the most part columnar in shape and many of them form what is apparently perfectly normal mucus. In some however it is not infrequent to encounter a type of cytoplasm containing very finely divided granules rather than mucus while others have cytoplasm resembling those normal cells that have recently extruded mucus. These cells receive their nourishment from an excellent blood supply that enters the lesion from its base and often the particular cells may be seen resting on a thin basement membrane in direct apposition to a capillary. Evidence of growth shows itself by hyperplasia and mitotic figures. Where this hyperplasia is active ulceration is not infrequent particularly if the growth is traumatized by hard stools.

The microscopic picture of an adenoma of the rectum therefore is one of abnormal growth in which the cells tend to a considerable extent to resemble normal rectal mucosa. This is only a tendency. They do show evidence of increased growth frequently and ulceration and inflammation even more frequently.

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Gross—The gross appearance of these lesions shows considerable variation. They may appear in any portion of the rectum but in our experience the vast majority have been within reach of the finger. They perhaps show a greater tendency to appear on the posterior wall. They may vary in type from a small single papillary projection on a long stalk to a flat sessile overgrowth. Occasionally one encounters large lesions resembling confluent papillary tumors that give the appearance of a sea anemone. Growths of this type not infrequently will become as large as the palm of the hand before producing symptoms. Adenomas of the rectum are generally soft to the touch unless there is considerable inflammatory infiltration. When the palpating finger is placed at the base of the adenoma it can be moved about with ease. The tumor can be lifted away from the muscularis of the gut and one gets the impression of the mucous membrane gliding over the muscularis.

SYMPTOMS

One would not expect a lesion of the type described above to produce many symptoms in view of the fact that it is freely movable and has not invaded the muscularis of the gut. Interference with motility should not be and is not great. Because these tumors are soft are not annular and are relatively small they offer no obstruction to the passage. The clinical syndrome then of abdominal cramps, nausea and vomiting and dyspepsia that is so often seen with cancer of the left bowel is for the most part absent.

The most common accident that occurs with an adenoma of the rectum is injury with ulceration and infection. Because of the great vascularity these tumors possess this is not infrequently associated with hemorrhage. This is the most important single symptom in adenoma of the rectum. This hemorrhage is generally painless but may be profuse. Such a hemorrhage often produces marked consternation in the patient. While the patient may lose enough blood to be of great clinical significance this as a general rule is not so. Usually the patient encounters brisk rather brief hemorrhage and that is all.

Another finding not infrequently associated with adenoma of the rectum particularly if it is a large adenoma and is well differentiated is the formation of mucus. At such times the chief disability is the massive secretion of mucus into the rectum which on proctoscopic examination can be shown to be due not to a colitis but to the active function of these tumor cells.

DIFFERENTIATION FROM MALIGNANT LESIONS

Some adenomas may remain in the rectum producing little or no trouble for many years. Others may appear rapidly show considerably less evidence of growth control and the clinical state of cancer frequently ensues early. It is difficult therefore to prognosticate the fate

of a particular lesion. There are certain characteristics however that are important. If it is remembered that these lesions are not occasionally associated with malignant change but are predestined eventually to show malignant change they may be studied with a more realistic attitude. It cannot be stated whether or not there exists any fundamental biologic difference between the cells of a cancer and those of an adenoma of the rectum. One can state however that for clinical purposes the main difference between the two should be considered one of degree or extent. When an epithelial overgrowth in the rectum invades it is cancer. If it has not invaded it is an adenoma. As a practical clinical expedient one chooses the muscularis mucosa as the boundary line in determining invasion. Thus where the lesion penetrates the muscularis mucosa we call it cancer where it has not invaded the muscularis mucosa we call it adenoma. Let us now examine the evidence that we can obtain to establish the presence of such penetration clinically.

Macroscopically, when the height of a tumor is greater than the diameter of its base that tumor is generally benign. When the tumor is not attached to the muscularis mucosa it can be displaced over the muscle layer with ease and is likewise generally benign. When a tumor begins to invade at the margins under the normal mucous membrane the adenoma becomes not so clear cut and the ulceration that so frequently develops remains permanent. The edema and inflammatory infiltration associated with such ulceration produce a lesion much more rigid and hard than the original adenoma. Thus ulceration in duration and chronicity make their appearance. With these findings appear different symptoms. The bleeding becomes much less in amount but more constant. Inflammation with its sequelae may produce sphincter spasm. The bowel wall becomes more rigid and as the tumor becomes annular symptoms of disturbed motility develop. A change in the stool habits is seen and the picture is now one of frank carcinoma.

Microscopically, these changes may be seen even more clear cut. As one would imagine when the growth becomes more sessile microscopically there is evidence of lateral invasion. Also one can clearly identify tumor cells going through and deep to the muscularis mucosa. With this entire picture there is often an increase in growth rate. Where this occurs there may be a lessening of differentiation. If so enough evidence of this may be obtained by the morphologic characteristics of a particular group of cells. Often however this growth rate change is not so great as to be determined easily in such a way.

During recent years physicians have come to rely upon the microscopic appearance of tissue as the most important single method in differentiating benign from malignant lesions. The surgeon has become accustomed to remove a portion of a tumor send it to a pathologist who usually has not seen the lesion as it naturally exists and to rely wholly upon the pathologist's opinion as to the nature of the lesion.

This reliance upon borrowed brains in the practice of surgery seems to result for the most part however in adequate care of the patient as long as the pathologist is well trained and as long as the tissue that he receives is adequate. The sole reliance upon such an opinion however when it is based upon the study of a biopsy taken from an adenoma of the rectum is frequently hazardous.



Fig 41—A Biopsy of polypoid tumor of rectum showing delicate projections into the lumen of the bowel with but little microscopic evidence of actual growth. B Gross appearance of the tumor from which A was taken. The diagnosis of cancer can be made easily from the gross appearance of the lesion.

Illustrative Cases—Because of the fact that invasion by an adenoma may not evidence itself throughout the tumor by a marked change in morphologic characteristics in all of the cells the study of a small fragment of this tumor microscopically often is misleading. In Figure 41 A for instance one sees finger like projections of a rectal adenoma in which the cells are regular and in which one can see very little evi-

dence of mitotic division and no hyperplasia. There is little inflammation and the cells seem to be producing a fairly normal type of mucus. From such a microscopic examination one cannot say that such a lesion is either benign or malignant.

This patient's clinical history is an interesting one. His chief complaint was one of rectal bleeding following bowel movements which had been present fairly persistently for the past 18 months. During this time the patient had been seen by several capable surgeons. When he was seen by us 14 different biopsies had been taken from an apparent adenoma which was situated about 2 inches above the peritoneal reflection on the rectum. These had all been diagnosed as a benign adenoma. The adenoma could not be removed easily from below because of its height, and because it was benign no one felt justified in subjecting this patient to an exploration from above. Figure 471 *B* illustrates the gross appearance of this tumor.

Because of the belief that these tumors sooner or later are predestined to invasion, the abdomen was explored after preliminary preparation of the bowel and much to our amazement gross evidence of regional lymph node metastases was seen which was verified by microscopic examination. Accordingly a single stage abdominoperineal excision of the rectum was done along with the associated lymph nodes. On gross inspection there is obviously present a polypoid type of carcinoma. This could never be ascertained by biopsy. The patient is now well without evidence of cancer 5 years after operation.

Figure 472 *A* illustrates the opposite phase of this problem.

This patient a woman 60 years of age had noticed rectal bleeding for several months following bowel movements. She presented several fairly large internal hemorrhoids for which she underwent a hemorrhoidectomy. At the time of the hemorrhoidectomy the surgeon noticed a small sessile growth about 2 cm. in diameter on the posterior rectal wall at the level of the coccyx. He removed a piece of this tissue for study (Fig. 472 *A*). Because of numerous mitotic figures, hyperplasia of the epithelium and apparent evidence of invasion of the submucosa, a diagnosis of low grade adenocarcinoma of the rectum was made by the pathologist who examined this tissue. Accordingly excision of the rectum was recommended. She was referred to us and when the entire tumor mass with the full thickness of the rectal wall was excised elliptically and studied an entirely different picture was shown (Fig. 472 *B*). While microscopically the cells show evidence of fairly rapid growth there is no evidence of penetration and this lesion is apparently localized on the surface of the mucous membrane. If a tumor must invade to be clinically malignant this is not cancer because it has not invaded. Accordingly the patient was told that no further treatment was necessary since her entire lesion had been removed. She has remained free from local recurrence for over a year.

The third case which we wish to present represents a borderline situation between the two previously described.

This patient was a male 52 years of age who complained of bleeding from the rectum following bowel movements not associated with pain or constipation which had been persistent for 4 months. Rectal examination showed a mass 5 cm. in diameter with elevated edges and ulcerated center on the posterior rectal wall 1 inch above the anal sphincter. It could be moved freely over the muscularis mucosa except in one small point where there was definite attachment to the rectal wall. Because of the ulceration one could not be certain that this attachment was not due to inflammation rather than epithelial infiltration and accordingly the entire lesion was excised with an elliptical excision well around the

t nor A sharp knife was used and the entire thickness of the ectal wall removed with the growth. It was possible to repair the defect with interrupted No. 0000 chromic catgut and the wound healed per primam.



Figure 422—A Biopsy of small intestinal tumor showing active growth. The presence or absence of invasion cannot be stated, however. B When the entire growth was removed with the adjacent rectal wall examination showed the lesion to be benign. This could not be determined from the microscopic picture alone as seen in A.

Figure 423 A shows the previous biopsy of this lesion which is of limited size. It is a polypoid type of growth. Whether this growth is benign or malignant cannot be determined from this section through

the growth after it had been completely excised. At the base of the ulcer one sees an abrupt change in the characteristics of the epithelium with definite invasion into the muscularis mucosa. This represents an early change to malignant



A



B

Fig 473—A Characteristic picture of rectal adenoma showing good differentiation and no evidence of active growth on the part of the tumor cells. B When the entire lesion was excised it was evident that very early invasion of the muscularis mucosa was taking place and that a lesion that seemed benign from biopsy was actually malignant when it was examined completely.

ulceration from so-called adenoma of the rectum. It is presumably possible that such local excision as was carried out here would have completely eradicated the tumor. Because the lymphatics had been invaded and because there was no

proof that lymph node extension had not occurred it was felt that the safest procedure would be a more radical one namely a single stage abdominoperineal excision of the rectum accordingly this was carried out and the result was a satisfactory colon cancer

COMMENT

The three cases presented illustrate well the fact that microscopic examination of a small fragment of an adenoma of the rectum is often misleading and incorrect. The surgeon therefore cannot rely upon pathological opinion expressed following such an examination. The pathologist has long known this and for years has asked for a portion of the base of the lesion. The surgeon has never given him this because obtaining a portion of the base of such an adenoma with a biopsy forceps is likely to produce a perforation of the bowel. It would seem that the best solution to this problem is a complete excision of the adenoma with the associated rectal wall under direct visualization and with primary closure of the defect. This will allow adequate microscopic study to determine the presence or absence of invasion. If the lesion proves to be benign it has been completely eradicated. If it proves to be malignant further surgery can be done.

Such treatment of an adenoma of the rectum is not hazardous. In our experience the patient is prepared preoperatively as if he were to undergo a one stage excision of the rectum. Following such a preparation adequate exposure of the tumor is obtained. If the lesion is low in the rectum this is easy; if the lesion is high in the rectum it may be necessary to section the external sphincter muscle. This can generally be closed by immediate suture and primary union is obtained. Again adequate exposure may better be obtained by a posterior incision in midline sectioning the anococcygeal ligament. The levatores are pushed aside and it is possible to deliver a considerable portion of the extra peritoneal rectum into the field. Where the lesion is still higher and in the peritoneal cavity we have felt it best to open the bowel and excise the tumor intra abdominally. In our experience the use of a sharp knife is far superior to the use of a cautery of any sort in the excision of lesions of the rectum of this type.

CONCLUSIONS

1 In adults adenoma of the rectum so frequently becomes clinically malignant that it should be considered as predestined to become malignant.

2 The proper treatment of such a lesion when benign is complete surgical extirpation.

3 Following such extirpation along with the underlying rectal wall, it is possible to determine the presence or absence of invasion microscopically.

4 Microscopic examination of a small fragment of tissue removed from an adenoma with a forceps is entirely inadequate as a method of establishing a diagnosis.

SQUAMOUS CELL CARCINOMA OF THE ANUS AND RECTUM

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This is a study from the Barnard Free Skin and Cancer Hospital of 40 patients with squamous cell carcinoma of the anus or rectum. The term squamous cell carcinoma includes epidermoid carcinoma, acanthoma and epithelioma but not melanoma. Squamous cell carcinoma comprises about 5 per cent of the malignant tumors in the anus and rectum and adenocarcinoma comprises the balance.¹ These two types of cancer differ from each other in cellular origin, in mode of extension, in radiosensitivity and in surgical treatment. Specifically we are not primarily discussing adenocarcinoma in this paper.

ETIOLOGY SEX INCIDENCE ORIGIN AND SITUATION

Etiology—The cause of squamous cell carcinoma of the anus and rectum is unknown. That habitus may be a factor in causation is indicated by the relative frequency of the disease in females as compared with males. Perhaps leukoplakia of the anus indicates a local susceptibility to squamous cancer. Leukoplakia sometimes precedes squamous cancer in the anus as well as on the vulva. Local operation is common prior to squamous cancer in the anus but is not causative. Lues, trauma and infection have all been held suspect as contributing etiologic factors but they cannot be proved to be primarily causative.

Sex Incidence—Females of this series numbered 34, males 6. The average age was 57 years, the youngest 27. The disease occurred both in the white and in the colored races.

Origin—Squamous cell carcinoma arises from epithelial cells of squamous type situated in the anal canal at or below the dentate line.

Situation—Squamous cell carcinoma occurs either in the anus or in the lower rectum. Most of the tumors seem to arise posteriorly in the anus. They are extremely rare higher in the intestine. Of our tumors 38 were in the anus or lower rectum, one was in the upper rectum and one in the descending colon. Squamous cell carcinoma elsewhere in the colon occurs uncommonly.

DIAGNOSIS

Diagnosis rests on (1) history, (2) physical examination which includes rectal digital examination and proctoscopy, and (3) biopsy.

History—Bleeding is the most common, the most constant and the earliest symptom. The blood may be dark in color but frequently is

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fresh and bright red Symptoms other than bleeding from the rectum are tragically often late symptoms Pain is common in anal cancer and is caused by ulceration or by invasion of the sphincter ani muscles Later in the disease as a result of invasion of the new growth along nerve sheaths pain develops in the buttock and sciatic nerve distribution Tenesmus may be distressing The bowel habits may change Stools may increase in frequency or constipation may occur There may be alternating constipation and diarrhea Tumors which are located externally can be felt by the patient They may form pus or mucus which discharges with defecation There may be perirectal abscesses or fistula in ano A fairly common symptom is a sense of fullness in the rectum which defecation may not relieve Tumors near the prostate or urethra can cause dysuria frequency or urgency of urination Loss of weight means *late* cancer Early cancer of the anus or rectum is not associated with loss of weight despite a rather wide spread impression to the contrary

TABLE 1—SYMPTOMS

Symptom	Squamous Cell Carcinom	Adenocarcinoma
Bleeding from rectum	Common	Common
Pain	Common	Rare
Change in bowel habit	Common	Common
Loss of weight	A late symptom	A late symptom
Duration of symptoms	18 months	13 months

Early symptom All others are late.

Physical Examination—No patient who complains of bleeding from the rectum should be dismissed without rectal *digital examination* Only one of our 40 anal tumors was out of reach of the finger To fail to examine the rectum may contribute directly to the death of the patient from cancer In earliest recorded history dating back before the Christian era insistence was laid on the necessity of digital examination of the rectum These injunctions have been ignored all too often Old Celsus about the year 1 A.D. adjured the doctor not to be deterred from the examination either by shame or stench

On *inspection* low tumors in the anus can be seen directly or pulled down into view by traction on the skin Early tumors look flat and raised like a pearly button or wart More advanced tumors are irregular ulcers whose borders are raised and pearly undermined and rolled A dirty slough may cover the ulcer and it may bleed easily Immediately neighboring tissue may be puckered owing to invasion by new growth On *palpation* one detects the characteristically hard indur

ated, inelastic quality with fixation of the growth on the underlying tissue.

Biopsy—With the lesion in full proctoscopic view a fairly generous bit of it is excised from the edge and another bit from the central portion of the tumor. Deep bites are required. The biopsy tissue is placed immediately into a bottle half filled with 10 per cent formalin solution, and sent to the laboratory.

Differential Diagnosis—The commonest ulcer in the anus is *fissure in ano*. Fissure is painful, tender to the touch, and causes spasm of the sphincter. Most fissures lie posteriorly in the anus. The borders of the fissure are smooth and usually a sentinel pile lies just below it. It in duration of its base or edges arouses suspicion, the fissure is excised for biopsy. *Hemorrhoids* rarely cause diagnostic uncertainty. One should not attribute rectal bleeding to hemorrhoids without performing a rectal digital examination and proctoscopy. When excised surgically hemorrhoids should be examined microscopically. The Mayo Clinic notes that about one out of every 100 hemorrhoids excised surgically shows histologic evidence of malignancy.³ *Warts* in the anus usually are simple papillomas. If infiltration is present the wart is excised for biopsy, including 0.5 cm. of normal skin with some of the subcutaneous tissues.

PATHOLOGY

Squamous cell carcinoma of the anus is of two general types, one of which Raiford calls the *discrete type* the other the *diffuse type*.⁴ The discrete type is well differentiated histologically and slow growing and relatively benign clinically; the diffuse type is more cellular, faster growing, more malignant clinically, and in this series more common in occurrence.

Tumors of the discrete type consist of well differentiated squamous cells with intercellular bridges, keratinization and epithelial pearl formation. Mitoses are infrequent in occurrence. This type is also called *acanthoma*.

On occasion, one encounters a basal cell type of carcinoma. This is, of course, understandable, since the anal canal is lined by modified skin. The smallest primary squamous carcinoma of our series measured 1 by 2 cm., and was located low down in the anal canal. The largest primary squamous carcinoma of this series was 8 cm. in diameter. It involved the entire anal canal and perianal skin, and extended up into the rectum to a height of 8 cm. above the external orifice. It was annular. There was perforation of the wall of the rectum above the sphincter and extension of cancer along the upper surface of the right levator ani muscle to the wall of the pelvis. This tumor was one of 5 tumors of this series which were annular; the remaining tumors were not annular and all but one were in the posterior half of the circumference of the anus. Buie and Brust found all of their 47 tumors posteriorly.⁵

Squamous cell carcinoma is derived from the epithelial cells which line the anal canal at or below the dentate line. Above the dentate line squamous cell carcinoma arises only with extreme rarity. When squamous cell carcinoma does arise above the dentate line it may be due to a reversion by the high cylindrical cells of the intestinal mucosa to an embryonal form which is capable of differentiation into squamous cell carcinoma.

One tumor of our series is of particular interest and seems to be unique. Histologically both squamous cell carcinoma and adenocarcinoma appeared in different portions of a tumor primarily in the descending colon. This tumor we studied through the kindness of Thompson who has reported it previously.⁶ The patient was a woman of 32 years; the resected descending colon showed that the tumor arose apparently from a polyp; the squamous portions were more deeply invasive than were the adenomatous portions; no metastases were found in four nodes; postoperatively there was recurrence locally with death 21 months after the first operation.

The tumors of our series were called clinically early when they were small, accessible and freely movable. By small is meant less than 4 cm. in diameter; by accessible is meant lying in the anus and not extending up into the rectum. Most such tumors in the gross were papillary, although some were ulcerative. Other tumors of this series were called clinically advanced. These tumors were larger, invasive, ulcerative and fixed. Some invaded the perianal skin, some the vulva or vagina, others penetrated the ischio-rectal fat after perforating the bowel wall; one extended along the levator muscles as a fistulous tract lined by cancer; one penetrated the prostate.

METASTASIS FROM SQUAMOUS CARCINOMA

A study of the common sites of metastasis from squamous cell carcinoma of the anus or rectum was made in 1937 at the Barnard Hospital. The results are set down in Table 2.¹ A series of patients with adenocarcinoma was used for comparison.

Since this table was published in 1937 nothing has been observed to alter the conclusions as to spread of metastases which are as follows: Squamous cell carcinoma metastasizes less often and less widely than does adenocarcinoma. Squamous cell carcinoma metastasizes chiefly upward, although also laterally and downward. Liver metastases are common from adenocarcinoma but not from squamous carcinoma. Inguinal metastases can occur either from adenocarcinoma or from squamous carcinoma but are more common from the latter.

TREATMENT

To cure cancer both the primary tumor and the regional lymphatics should be removed. The attack on squamous cell carcinoma of the anus and rectum can be either surgical or radiological.

The Surgical Attack—*Perineal Excision*—An operation based on ideal principles will remove both the regional lymphatics and the primary tumor. To determine the scope of the ideal operation of perineal excision of the anus we may recall what Miles meant by his three zones of spread from cancer of the rectum. By the downward zone Miles meant the perianal skin, the ischio-rectal fat and the external sphincter muscle. By the lateral zone he meant the lymphatics of the levator ani and coccygeus muscles, the prostate, the pelvic peritoneum, the base of the bladder, cervix uteri and broad ligaments. These are the two zones with which the operation of perineal excision is concerned.

In order to conform with these theoretical considerations the operation of perineal excision of the rectum and anus is performed as follows. The patient is given sulfasuxidine for 5 days in the hospital. Usually a loop colostomy is performed as the first stage of the opera-

TABLE 2—METASTASIS

Site	Squamous Cell Carcinoma of Anus	Adenocarcinoma of Rectum
Zone of Miles		
1 Downward (skin, fat, etc.)	12	5
2 Lateral (levators, etc.)	9	11
3 Upward (mesocolon, etc.)	0	14
Liver	0	10
Inguinal nodes	4	3
Lun	1?	0
Bone	0	2
Total metastatic foci	26	45
Total patients	10	25

tion. At the second stage the patient is placed either in the left lateral the jack knife or the lithotomy position as preferred by the surgeon. An indwelling catheter is placed in the urethra and left open.

The incision in the skin of the perineum should be unusually wide in squamous cell carcinoma. Furthermore, since it is usually impossible as well as inadvisable to close the anus by purse string suture, it is better first to make the skin incision, then to mobilize the skin somewhat and finally to close off the anus by suturing together the skin flaps with stout fishline or malleable steel wire. After this preliminary closure of the anal orifice, gloves are changed and the field is reprepared to obtain asepsis.

The skin from coccyx to the midpoint of the perineum and from tuberosity to tuberosity of the ischium is removed with the anus. When the tumor has invaded the vaginal septum, a good portion of the posterior vaginal wall is included in the tissues removed; sometimes the entire posterior vaginal wall is thus removed. The coccyx need not be removed. The middle sacral artery is ligated beyond the tip of the

coccyx and the fascia propria of the rectum is entered. It is important to remove all the tissues in both ischiorectal fossae completely. Anteriorly in the male the urethra is identified with the prostate in the female the vagina is stripped from the rectum. The levator muscles are excised as close to the walls of the pelvis as possible. The middle hemorrhoidal arteries are ligated. The peritoneum is identified anterior to the rectum and entered. a cuff of peritoneum is cut about 2 cm away from the bowel. The intraperitoneal part of the bowel which for convenience we shall call the sigmoid is grasped drawn down snug doubly clamped and cut between clamps. The line of incision is carried posteriorly to remove the lower portions of the mesosigmoid, at least up to the bifurcation of the superior hemorrhoidal artery. This line marks the height to which the dissection is carried. In squamous cell carcinoma it need not be very high above the peritoneum, because squamous cell carcinoma does not spread upward in adenocarcinoma it should be as high as possible and as much mesosigmoid as possible removed because adenocarcinoma spreads upward. These tissues in the upward zone of spread are easier to remove from above and that is why at Barnard Hospital we prefer the abdominoperineal operation recommended by Miles for adenocarcinoma of the rectum.

The perineal operation is completed by turning in the sigmoid and suturing it to the peritoneum. The peritoneum is closed sulfanilamide powder is sprinkled in it a Penrose drain is inserted and the perineal wound is closed with interrupted silk sutures.

Various names have been applied to the perineal operation such as Harrison Cripps Quenu Tuttle Lynch and Kraske. The last one is used at Barnard Hospital. With a preceding abdominal loop colostomy it is called the Lockhart Mummery operation.

Inguinal dissection is theoretically indicated because squamous cell carcinoma can metastasize to the inguinal region. Two of our patients developed inguinal metastases from 1 to 4 years after perineal excision of squamous carcinoma of the anus and rectum. Had these patients had a so called prophylactic inguinal dissection it is possible theoretically that their lives might have been saved. It is possible also that prophylactic inguinal dissection might have done them no good because spread of cancer to these nodes may not have occurred until after it had metastasized elsewhere.

The argument against inguinal dissection is that the inguinal region is not the first lymphatic barrier against squamous carcinoma but it is the second barrier. The first barrier it may be argued is formed by the tissues in the downward and in the lateral zones of spread. Moreover the distance from the anus to the groin is great and in one operation one could not hope to remove both the inguinal nodes and the anus together with the intervening tissues in one block. Another argument against inguinal dissection is that when metastases from squamous cell carcinoma have become microscopically demonstrable in the in

guinal lymph nodes the dissection has not cured even one of our patients. Four of our patients had inguinal dissection and also radiation for metastatic involvement of the inguinal lymph nodes and all died of recurrent cancer in the groin. By comparison inguinal dissection for squamous carcinoma metastatic from the penis has proved effective at Barnard Hospital in 5 patients.

At Barnard Hospital opinion on inguinal dissection is divided. The operation was done for squamous cell carcinoma of the anus up to 1940 but it has not been done since that time. By comparison this operation is always done for cancer of the penis if the patient's consent is obtained.

Exploratory Laparotomy—This operation is of no theoretical value in squamous cell carcinoma of the anus and rectum. The purpose of the operation is to determine (1) liver involvement, (2) spread in the upward zone of Miles meaning mainly metastatic involvement of the sigmoid mesocolon, (3) peritoneal involvement and (4) tumor operability as determined by palpation through the abdomen. Squamous cell carcinoma almost never spreads to the liver. It almost never spreads to the sigmoid mesocolon in the upward zone of Miles. It does not involve the peritoneum of the pelvic floor because the primary tumor almost never extends to that height. For the same reason its operability cannot be determined from the abdomen because the tumor cannot be felt from the abdomen except in the very rare instances in which squamous cell carcinoma is primary in the rectosigmoid or descending colon or higher in which event exploratory laparotomy is indicated and the tumor is to be treated surgically as though it were actually adenocarcinoma.

Colostomy—Colostomy is not avoidable when surgery is used to treat squamous cell carcinoma of the anus or rectum. Colostomy is avoidable when radiation is used to treat the disease as will be shown later. With surgery the only question is should the colostomy be perineal or abdominal in situation?

This again may be a matter of personal preference. Prior to his death in 1938 Dr. Ellis Fischel, then surgeon on the Barnard Hospital staff, favored colostomy of the perineal type when feasible. In squamous cell carcinoma it sometimes is feasible and 4 of his patients survived cancer free 5 years or more with perineal colostomies. Two had trouble with their perineal colostomies, 2 did not. One of them had a stricture with attacks of partial intestinal obstruction; her stoma was too tight. The other developed prolapse through the stoma of about 12 inches of sigmoid; this was debilitating and an attempt at repair resulted in death postoperatively from pneumonia. Since 1938 abdominal colostomies have been performed at Barnard Hospital. These have caused no serious complications; minor complications have been stenosis, weakness of the rectus muscle and hernia. Prolapse of the abdominal colostomy has never been debilitating and none has neces-

sitated operative repair. Several stenotic abdominal colostomies have been widened by secondary operation.

The Attack by Radiation—Squamous cell carcinoma of the anus is radiosensitive but its metastases wherever they be are radioresistant. In its early stages in the anus that is to say before it has metastasized, squamous cell carcinoma can be cured by radiation alone and without surgery. Our criteria for a tumor which can be called clinically early have been given. The tumor must be small that is under

TABLE 3—THE CANCER FREE SQUAMOUS CELL CARCINOMA OF THE ANUS OR RECTUM

A. SURGERY FOR PRIMARY TUMOR				
Sex and Age	Surgery for Primary Tumor	Date	Subsequent Surgery	Cancer Free
F 30	Babcock operation	1933	Prophylactic inguinal dissection 1933	11 years, 1944
F 75	Internal excision	1934	None	5 years, 1939
F 48	Perianal excision	1934	None	9½ years, 1944
M 49	Perianal excision	1935	Prophylactic inguinal dissection 1935	6 years, 1941 Died 1941 post op.
F 61	Lockhart Mummery	1938	None	5 years, 1944

B. RADIATION FOR PRIMARY TUMOR				
Sex and Age	Radiation for Primary Tumor	Date	Subsequent Surgery	Cancer Free
F 48	Radiation	1934	Prophylactic inguinal dissection 1934. Fixation of ulcer of anus 1934	10 years, 1944
F 59	Radium	1939	Prophylactic inguinal dissection 1939. Drainage of ischio-rectal abscess 1939	5 years, 1944
F 60	Radium and X-ray	1940	Whitehead operation for anal ulcer 1941. Abdominal colostomy for anal ulcer 1941	4 years, 1944
F 53	Radium	1940	None	3½ years, 1944

4 cm. in diameter it must be accessible that is located in the anal canal and not extending up into the rectum. It must be superficial and not infiltrating deeply.

Radiation is available in three general types: radium element, radon, and x-ray. Radium and radon have cured cancer in this series; x-ray alone has not. Radium is used at Barnard Hospital not by preference, because radon is preferred but simply because radon is not always available.

Results—The success of the attack on squamous cell carcinoma of the anus and rectum can be viewed in the light of the results obtained. A list of the cancer free patients has been prepared in Table 3. This list includes only patients who were cancer free when last seen or who survived 5 years clinically free from cancer but died from other cause. It includes chiefly 5 year survivors. It includes no patient without microscopic confirmation of the diagnosis of the primary tumor. Unfortunately it does not include the data on whether or not the re-

TABLE 4—CHOICE OF TREATMENT

1 RADIATION		
	Squamous Cell Carcinoma	Adenocarcinoma
Primary tumor in anus Primary tumor involving rectum Regional lymphatics and metastases	If tumor is small accessible Not curable Not curable	Not curable Not curable Not curable
2 SURGERY		
	Squamous Cell Carcinoma	Adenocarcinoma
Primary tumor in anus Primary tumor involving rectum Ideal operation	If tumor is large or questionable Curative and preferable Lockhart Mummery 2 stage loop colostomy and perineal excision Of debatable value	Curative Curative Miles operation 1 stage abdom inoperneal Not indicated
Prophylactic inguinal dissection Inguinal dissection in the presence of metastases	Not successful	Not successful
3 PALLIATIVE IRRADIATION		
	Squamous Cell Carcinoma	Adenocarcinoma
Inoperable tumor Recurrent tumor	Valuable Valuable	Of little value Of little value

gional lymphatics contained metastatic carcinoma microscopically because the perirectal lymph nodes were not examined histologically in every case.

Five Year Rate of Survival—In the 5 year period that is up to 5 years ago 17 patients were treated and 7 survived cancer free 5 years or more a survival rate of 41.2 per cent. During this period 18 patients either refused treatment or were hopelessly incurable when first seen. Five patients have been seen or treated during the past 5 years to make the sum total of 40 of the series.

Operative Mortality—There were 3 postoperative deaths among 14 patients who were operated upon either with the Miles Babcock, Lockhart Mummery or perineal excision operation. There was no mortality following inguinal dissection or following radiation.

Operability—Of the 40 patients 19 had either surgery or radiation treatment of the primary tumor in the hopes of ultimate cure. Criteria of inoperability were inguinal metastases, extensive local invasion or postoperative recurrence. Fixation alone is not a criterion of inoperability.

Surgery versus Radiation—Only small accessible tumors in the anus are suitable for radiation. Other tumors should be removed by radical surgery. Small tumors are tumors less than 4 cm in diameter. If annular they are not considered small. Tumors are accessible when they are easy to get at, that is, when they are low in the anal canal. These are the only tumors suitable for radiation with the hope of ultimate cure. In case of doubt, surgery is preferable to radiation. Large tumors, tumors which look very malignant even if small, and high tumors should be treated surgically. Radiation can cure only the primary tumor and not the metastases. Radiation is objectionable because of its ineffectiveness against metastases and because of its painful local sequelae. The ideal treatment of cancer includes the removal of the regional lymph nodes, and radiation cannot do this. Surgery is objectionable because of the operative mortality and because it entails the sacrifice of the function of the sphincter and necessitates a colostomy.

The ideal surgical operation seems to us to be the Lockhart Mummery operation. At the first stage a loop colostomy is made through a left McBurney incision without abdominal exploration. At the second stage the anus and rectum are excised by the perineal route.

Ideal radiation is in the form of radon. γ Radiation has not proved curative when used alone and has required supplementary radium treatment in our experience. However, γ radiation is of great value in the palliative treatment of squamous cell carcinoma of the anus or rectum either when it is inoperable or when it is recurrent locally. Indeed, it rendered one inoperable squamous carcinoma operable and the patient survived 1½ years after γ radiation followed by a Lockhart Mummery operation before dying of carcinoma recurring locally.

SUMMARY

Squamous cell carcinoma of the anus or rectum arises from cells of epidermoid type which line the anal canal. It can be produced experimentally in animals. In the human it is more common among females than among males. It apparently takes 2 years to grow completely around the anus and to become annular. It is relatively slow growing when compared with adenocarcinoma and shows relatively greater local invasiveness but relatively less frequent metastases. It metastasizes

chiefly in the downward and lateral zones of spread and rarely in the upward zone unless the primary tumor is situated above the lower rectum which is a very rare occurrence. It can be treated successfully either by surgery or by radiation and 7 of our 40 patients survived 5 years or more clinically cancer free.

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ABDOMINAL SILICOSIS (DUE TO TALCUM POWDER) AND CANCER

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DURING the course of the past year at The Barnard Free Skin and Cancer Hospital we have studied and treated 2 patients whose case histories illustrate a grave and inadequately appreciated postoperative complication. The purpose of this report is to present a summary of the case histories of these 2 patients insofar as they concern the methods of entrance of talcum which is predominantly magnesium silicate into the animal tissues, the role played by it in complicating the postoperative course of patients, the pathological effect of talcum on animal tissues, the consequences clinically considered of abdominal silicosis and the prophylactic measures to be taken against the initiation of the disease. Primarily of course our interest centers in the harmful effect of talcum scattered in the abdominal cavity and it is chiefly with this harmful effect that this report will deal.

CASE REPORTS

CASE I—A woman 58 years old whose history was not noteworthy except as it pertains to symptoms pointing clearly to carcinoma of the stomach presented herself for treatment. X-ray studies confirmed the diagnosis of carcinoma of the stomach. Operative therapy was suggested and this counsel was accepted by the patient. Laparotomy disclosed such extensive invasion of the stomach by the type of malignant growth classified as *limitis plastica* that a total resection of that organ was denied with anastomosis of esophagus to jejunum. The immediate postoperative course and the subsequent stay in the hospital were uneventful.

Five months subsequent to operation the patient sought aid for symptoms of intestinal obstruction and she was therefore subjected to a second laparotomy for relief of pain, nausea, vomiting, distention and other typical accompanying symptoms and signs. Laparotomy disclosed a localized kink in the ileum responsible for an obstruction due to adhesive peritonitis. In addition there were numerous peritoneal adhesions disseminated throughout the abdominal cavity and also a scattering of small whitish nodules most of them in the serosa or on both the parietal and visceral peritoneum. The appearance of these nodules made the diagnosis of disseminated or metastatic carcinoma almost a foregone conclusion. Nevertheless one of them was excised for microscopic diagnosis in order to make assurance doubly sure. The pathologist reported that the nodule was a granuloma of the foreign body type and that the exciting foreign bodies were crystals of talcum powder. There was no evidence of cancer. Studies of the microscopic slides under polarized light showed that the luminous crystals had an extinction angle corresponding to that which is specific for magnesium silicate (talcum).

CASE II—This patient 68 years old entered the hospital with all the symptoms of an operable carcinoma of the descending colon. He was subjected to laparot-

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omy which confirmed the preoperative diagnosis. The operative procedure consisted in exteriorizing a large section of the descending colon and some of the transverse colon. The exteriorized loop was resected a few days later leaving the patient with a double barreled colostomy. There were some postoperative complications, but they have no bearings on the particular phase of the case history that is under present discussion.

Five weeks after the first operation a secondary operation was performed for closure of the colostomy and reestablishment of the intestinal lumen. At this second operation it was found that there had developed in the lower angle of the abdominal wound a small hard nodule 2 cm in diameter that seemed to be either a metastasis or a malignant implantation from the primary tumor. This nodule was excised for biopsy study and proved to be a foreign body granuloma of the talcum variety. The microscopic diagnosis of talcum granuloma was confirmed by studies under polarized light.

It is evident from the recital of these two case histories that talcum powder is a factor that has to be reckoned with in surgery. Insofar as these particular case histories are concerned the problem is solely one of differential diagnosis but its roots sink much more deeply than that into the field of surgical thinking. I propose to make clear the role of talcum powder as a surgical hazard.

CHEMICAL NATURE OF TALCUM

As used in industry the word talcum refers to a substance which meets certain physical requirements rather than one which has a definite chemical composition. However the mineral talc is a specific substance hydrous magnesium silicate ($\text{H Mg}_3[\text{SiO}_3]_4$). Several accompanying impurities occur with it such as serpentinite (hydrous magnesium silicate) and tremolite (calcium magnesium silicate). It is evident therefore that viewed either from the point of view of chemistry or industry talcum may be considered in general as a silicate and furthermore that any pathological lesions resulting from its presence in animal tissues constitutes a type of silicosis.

HISTORICAL DATA

The earliest reported clinical work on intra abdominal complications arising from powder in the peritoneal cavity had to do not with talc but with lycopodium which is a dusting powder made from the club mosses to the spores of which the peritoneum reacts almost exactly as it does to talc. Hippolyte Martin in 1881 and Muscatello in 1895 demonstrated experimentally the ill effects of lycopodium powder on the peritoneum. Independently Carlo Bezzola and von Podwyssozki studied experimentally similar deleterious effects due to intra peritoneal instillation of diatomaceous earth (kieselguhr). In 1913 Lambert showed that even in cell growth *in vitro* lycopodium spores evoked a foreign body response with outgrowth of connective tissue cells wandering cells and giant cells. Marchand of Leipzig in 1921 corroborated these findings experimentally by showing the severe ir

irritant qualities of lycopodium powder when injected intraperitoneally in animals. During the past 10 years considerable experimental work has been reported emphasizing the irritant qualities of talcum when injected intraperitoneally intrapleurally intrapericardially or subcutaneously. In fact in a certain type of heart disease talcum has been recommended to produce pericardial adhesions in an attempt to promote better collateral circulation.

In 1923 Roth published the first contribution to the clinical chapter of postoperative complications arising from dusting powders. In this instance the dusting powder was lycopodium spilled from a glove which tore during a laparotomy. The results of this accident were three subsequent laparotomies for adhesive intestinal obstructions supposedly due to tuberculosis (many milium nodules were found on the peritoneum) until pathologic examination disclosed that the milia represented foreign body reactions to spores of lycopodium. In 1933 Antopol reported 6 cases of complications resulting from lycopodium spores in the urinary bladder testicle kidney peritoneal cavity neck and female breast. In the same paper Antopol recorded the first case of intraperitoneal granuloma due to talcum. In 1937 Fineberg described talcum powder granulomas in detail shortly after which the work of Douglass Ramsey and McCormick reemphasized the subject. Hyron and Welch and German expanded the field of study and finally the whole chapter was reassembled and a complete bibliography provided by Seelig and Verda.

PATHOLOGY

The presence of talcum powder in the animal body causes a tissue proliferation which takes the form of a granulomatous productive inflammation. These granulomas have the typical morphology described in all textbooks of pathology. In particular they correspond to the so called foreign body granulomas in which the accumulation of cells form around the talcum crystal or crystals. In spite of the fact that these crystals are highly refractile they are not always readily detected when the microscopic examination is made with ordinary illumination. When however the sections in question are examined under polarized light the talcum crystals stand out as brilliantly illuminated structures that cannot escape observation (Figs 424 and 425). Other substances beside talcum are disclosed by polarized light but for each substance there is specific means of identification. Owing to the numerous substances combined in talcum the microscopic picture of the crystals varies within broad limits ranging from star tetrahedral plates of varying size to spear shaped shafts and amorphous granular accumulations. Figure 426 represents the crystals as seen under a magnification of 50 diameters of the particular variety of talcum in use in The Barnard Free Skin and Cancer Hospital.

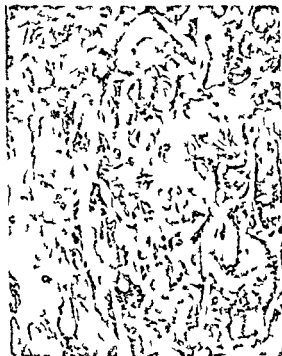


Fig 474—Talcum granuloma showing tissue reaction with giant cells of foreign body type and talcum crystals ($\times 116$)

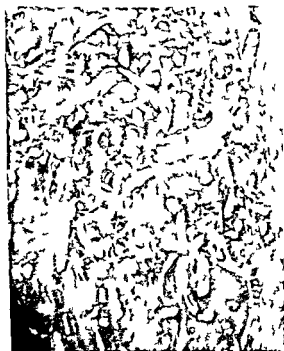


Fig 475—Same section shown in Figure 474 but seen under polarized light. Bright structures are talcum crystals ($\times 116$)

ROUTES OF ENTRANCE OF TALCUM INTO THE BODY

In general it may be said that talcum finds a place in the body as a result of escape from the rubber gloves worn by the doctor. This comes about through failure to wash the talcum off the surface of the gloves or its escape through accidental punctures or rents in the gloves. Studies by Weed and Groves show that in 74.4 per cent of all operations some gloves are torn and that 22.6 per cent of all gloves used show rents or punctures. These data were obtained by Weed and Groves through a period of 20 months of operating using a total number of 35,163 gloves. Some months 32 per cent of the gloves showed rents or punctures. The high incidence of perforation of rubber gloves during operation (22 per cent) was recently emphasized in



Fig. 4-6—Talcum crystals ($\times 10$)

an editorial in the British Journal of Surgery. Cerman found that in a series of 50 patients 40 showed intraperitoneal talc that had been deposited accidentally during a previous laparotomy.

The noxious properties of talcum are thrown into bolder relief when one learns that it is a trouble maker elsewhere than in the peritoneal cavity. Granulomas resulting from talc implantation have been described in the rectum, vagina, cervix and brain and in healing wounds by Antopol and Robbins, Erb, Antopol, Fineberg, Ramsey and Douglas, Grieco, Cline and others. We have heard by way of a personal report of troublesome consequences following the accidental entrance of talcum powder into the conjunctival sacs of operating room nursing personnel. On the basis of a study of the talcum hazard in the preparation of rubber gloves for sterilization made by the Illinois Division of

Industrial Hygiene Kronenberg suggests it would be wise to institute measures to control and remove talc dust in order to avoid health risk to nurses

SYMPTOMATOLOGY

The symptoms vary with the site in which the talcum finds a resting place. When granulomas are present in such places as open wounds, rectum, vagina, cervix or uterus, symptoms develop referable both to the presence of granulation tissue that stubbornly resists ordinary treatment and occasions mild or more pronounced discomfort, as well as to the presence of a purulent or sanguineous discharge. When, however, the powdered talcum has found lodging place in the peritoneal cavity, the story is a very different one. It is conceivable that talcum granulomas may be set up in the peritoneal cavity and run a symptomless course. It is possible, furthermore, that the fibrosis due to talcum may not make its presence known through symptoms, as is witnessed by the fact that every surgeon has been baffled at times to explain those unusual cases of almost complete obliteration of the peritoneal cavity with insignificant or no accompanying clinical symptoms. Fibrosis in the peritoneal cavity means peritoneal adhesions, and only by grace of fate do adhesions fail to set up the grave symptoms incident to partial or complete intestinal obstruction. It is these symptoms of intestinal obstruction that constitute the sum and substance of abdominal silicosis, otherwise termed talcum peritonitis or abdominal silicosis. These symptoms may run the gamut from signs of indigestion, through those of incomplete intestinal obstruction, on to those of complete closure of the intestinal tract by kinking or by cicatricial contraction.

It is very easy to demonstrate the role of talcum powder as an inciting agent in the production of adhesive peritonitis by injecting into the peritoneal cavities of rats suspension of talcum in water. Figures 477 and 478 show the contrast between the peritoneal cavity and its contained viscera in a normal rat (Fig. 477) and that of a rat which had been injected, intraperitoneally, under chloroform anesthesia with 7 cc. of a 5 per cent watery suspension of talcum powder two days before it was sacrificed (Fig. 478). The peritoneal cavity of the talc rat shows numerous adhesions causing kinks in the intestinal tract. In addition, the liver is seen to be bound to both stomach and diaphragm and the spleen is bound down by adhesions; there are besides numerous talc granulomas on the surfaces of the intestines, on the omentum and on the parietal peritoneum.

Such being the case, there is no small amount of irony in the thought that although for several decades surgeons have been developing the most refined technic as a prophylactic against the formation of adhesions in the peritoneal cavity, they have all the while been seeding the operative field with the one agent best designed to initiate the very state of affairs that they sought to avoid. It is most difficult to wash

the talcum off the urface of gloves (one source of dissemination and it is very easy to puncture the finger tip of a glove By act



weight a glove finger tip may hold comfortably 100 mg of talcum a quantity that is sufficient to play hob in the peritoneal cavity. In addition to the gloves as a source of spread of talcum we have to

think of the gauze sponges and pads that may have had the powder wafted on to them in the process of dusting it on the surgeon's hands.

There have been other investigations showing that contamination of the peritoneal cavity with talcum is a more frequent tragedy than it is commonly thought to be. German examined bits of omentum from 50 patients who had had a previous laparotomy and he found that in 40 of these patients (80 per cent) he could demonstrate the presence of talcum crystals. All in all, therefore, it is readily seen that the accidental dissemination of talcum powder in the tissues is more frequent than one would think off hand and that something must be done about it.

DIAGNOSIS

The problem of diagnosis may be dismissed in very few words. In every case of postoperative intestinal obstruction in which there is no other demonstrable cause, one should always think of the possible presence of talcum powder unless talcum powder had not been used in the previous operation or operations. Confirmation of this suspicion cannot be secured of course until the abdominal cavity has been opened and inspected. It may even be necessary to make one or more suitable biopsies from the omentum or other selected sites in order to establish the presence of talcum crystals. If one can demonstrate numerous whitish milium nodules or larger whitish plaques or if one encounters one or more granulomatous foci, one can be reasonably certain that he is dealing with a talcum adhesive peritonitis. Microscopic examination may or may not confirm the diagnosis.

DIFFERENTIAL DIAGNOSIS

In our experience only three diseases have to be differentiated from talcum peritonitis. These are tuberculosis of the peritoneum, carcinoma of the peritoneum, and simple adhesive peritonitis (postoperative). The two cases already cited illustrate the confusion that may be occasioned in relation to carcinoma. We have also encountered a case in which tuberculosis was in question and was not ruled out with assurance until the biopsy revealed the presence of talcum crystals and the absence of tuberculosis. As a matter of fact, in almost every instance in which differentiation becomes necessary, it will in the last analysis rest on biopsy studies rather than on an analysis of symptoms or other signs. There must be a large number of cases hitherto unrecognized in which there are no signs or symptoms pointing to intestinal obstruction but a persistent symptom complex of abdominal malaise instead with more or less subacute pain, stubborn indigestion and gaseous disturbances of various sorts. In these cases one may suspect that talcum was the agent at work, provided there had been a previous laparotomy and also provided there was no other discoverable pathological lesion, but it is difficult to see how one could confirm the suspicion of the presence of talcum unless the symptoms

grew to such proportions as to warrant the advisability of an exploratory laparotomy

PROPHYLAXIS AND TREATMENT

The point need not be stressed that a substance that has the potentiality both of creating highly confusing diagnostic difficulties (as illustrated by the case histories introducing this paper) and of precipitating grave surgical hazards has no place in surgery. The avoidance of both these pitfalls lies either in reverting back to the old wet, boiled glove technic or in substituting for talcum a powder that serves the same purpose and that is free from hazard.

As for treatment nothing can be done to remove the talcum from the abdominal cavity for the reason that it is too widely disseminated. The only possible course is to correct the resultant anomalies that are responsible for the consequent intestinal obstruction. This procedure may have to be repeated an indeterminate number of times and therein lies the major tragedy of talcum as used in abdominal surgery. In other parts of the body it may be possible now and then to excise the offending silicotic focus.

Any attempt to find a substitute for talc must be based on two fundamental considerations: (1) The substitute powder must possess such a degree of actual or potential solubility as to be disposed of rapidly and completely by some form of peritoneal or tissue absorption. If this be not true the powder collects in the peritoneal cavity as masses or plaques which induce foreign body granulomas which in turn result in adhesions or the powder sets up foreign body reaction in wounds or on mucous membranes. (2) The powder must possess such a degree of insolubility as to withstand steam sterilization without loss of that dusting property which serves to prevent the glove surfaces from adhering.

Our experiments in The Barnard Free Skin and Cancer Hospital dealt with 74 dusting powders of various types. We used large rats as our experimental animals and we studied the various powders with the object in view of determining their capacity for withstanding sterilization and their toxic or nontoxic or other undesirable effects on animal tissue. In particular we studied the tolerance of the peritoneal cavity for the various powders.

The results of the experiments may be summarized very briefly by saying that with one exception every powder that successfully met the test of steam sterilization produced pathologic lesions of one type or another in the peritoneal cavities of the test animals, i.e. powder plaques, granulomas, adhesions or peritoneal serous exudates. The one exception was potassium bitartrate which whether it was strewn on the abdominal viscera through a laparotomy wound or injected into the peritoneal cavity as a watery suspension in varying strength was rapidly disposed of without causing even the slightest untoward toxic or physical effects local or general in any of our experimental ani-

mals Since there is no certain information as to how potassium bitartrate is disposed of after its entrance into the peritoneal cavity we are making a special but so far inconclusive study of this point However we are assured by our work both of its rapid absorption and of the absence of any symptoms of toxicity with appropriate dosage There are conflicting reports as to whether or not the use of the potassium bitartrate tends to shorten the life of the gloves Even if it does it would seem that this trivial economic factor does not merit very serious consideration when weighed against the grave hazards incident to the use of talcum

CONCLUSIONS

1 Talcum powder having gained entrance into the animal body sets up a series of pathological changes that may deceptively resemble cancer or tuberculosis

2 Talcum powder is under any circumstance a grave menace in surgery Once having gained entrance into the animal organism this powder sets up a reactionary productive inflammation that is permanent and progressive and that may be provocative of almost insuperable complications Furthermore postoperative residual talcum has been demonstrated by one investigator in various intra abdominal viscera in 80 per cent of patients he examined

3 It is certain that even meticulous care in washing off the surface of rubber gloves before operating does not guarantee against contamination of the operative field with talcum

4 The difficulty in substituting for talcum lies in the fact that whereas an insoluble powder like talcum (hydrous magnesium silicate) sets up a granulomatous foreign body reaction a soluble dusting powder dissolves during the process of sterilization of the gloves rendering them adherent and thus difficult or impossible to put on Dry sterilization of the gloves might be regarded as a solution of this difficulty but it does not meet the rigid requirements of aseptic surgery and is highly destructive to the life of the gloves Boiled gloves are sloppy and generally undesirable

5 Potassium bitartrate meets the physical requirements imposed by steam sterilization It is readily and harmlessly disposed of by the body tissues and fluids It causes no consequent peritoneal adhesions Since therefore there are no demonstrable risks attendant on its use it may be recommended as a substitute for talc in powdering rubber gloves

6 It is important that in the process of sterilization the potassium bitartrate should be subjected only to the now standard and accepted technic for sterilizing rubber gloves namely fifteen minutes of autoclaving under 15 pounds of steam pressure

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CARCINOMA OF THE VULVA

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THE purpose of this communication is to discuss the topic of carcinoma of the vulva insofar as it is related specifically to the clinical material that has passed through the Barnard Free Skin and Cancer Hospital during the 15 year span from 1925 to 1940 and to relate the data developed from this analysis of the 63 patients studied with the already known clinical facts bearing on carcinoma. In round figures carcinoma of the vulva constitutes 4 per cent of all the genital cancers in women.

ANATOMY

It has been agreed by almost general consent that the term vulva should embrace the labia majora and minora, the vestibule, prepuce, fourchette, clitoris and Bartholin's gland. In general it may be said that such an anatomical classification is in large measure based on topography rather than on specific cell structure, for as a matter of fact if we except Bartholin's glands all carcinomas of the vulva belong in the group of squamous cell carcinomas, all of them drain into the inguinal and femoral lymph nodes regularly and into the iliac and obturator nodes and all of them run typically similar courses. Exception is made of the carcinomas of Bartholin's gland only because these growths originating as they do in a glandular organ take on the venous form that characterizes adenocarcinoma as contrasted with the squamous cell type of growth noted above.

In our series of 63 cases there were only 7 instances of origin in Bartholin's gland. There were only 2 cases that we felt assured originated in the clitoris and likewise 2 in which the primary lesion seemed to have been in the prepuce. Such localizations cannot be made always with too great a degree of dogmatism because one is often hard put to it to determine what constitutes the point of origin in a growth that shows extension in various directions. Of course where the lesion is so small when first seen that it is limited to the clitoris or to its prepuce and when a biopsy on this lesion establishes the diagnosis of carcinoma then we are on safe grounds in localizing the growth anatomically.

INCIDENCE

Racial—The distribution according to race shows in our series the same striking difference that has been notable for years as regards the comparative frequency of malignant tumors in the pigmented as con-

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trasted with the white races. We do not purpose to discuss here the relation of normal skin pigment to the incidence of carcinoma but we shall content ourselves merely by stating the fact that in our series of patients 59 were white and 4 were Negroes.

Age and Marital Status—As regards age incidence there is also little to be said specifically regarding our patients that is at variance with the well known facts regarding the age incidence of cancer in general. It is not necessary to discuss the well established fact that cancer is predominantly a disease of the late middle and advanced age periods of life. Carcinoma of the vulva furnishes no exception to this rule. In our series there were no patients under 20 years of age. In the 20 to 30 year old group there were 2 patients; in the 30 to 40 year group there were 5 patients; in the 40 to 50 year group 11 patients; in the 50 to 60 year group 11 patients; in the 60 to 75 year group 25 patients; and in the group over 70 years there were 9 patients. Of all these patients 60 were married and 48 had had at least one child.

PREDISPOSING CAUSES

Among the predisposing causes there comes into consideration the role of *irritating vaginal discharges* and *trauma*. In our series of pa-



Fig 49—Tumor of vulva simulating condyloma that proved to be squamous cell carcinoma.

tients there was nothing pointing either to a temporal or causal relationship between these factors and the subsequently developed malignant growth. Except in unusual instances of violence the vulva is not

a site of trauma and the dermatitis resultant from acrid and irritating vaginal discharges has not been demonstrably provocative of carcinoma in our patients. Since chronic irritation is a factor well known to be of significance in the chain of circumstances leading to cancer we cannot exclude chronic skin irritation as a possible precursory significant agency applicable to the vulva. We can only say that in our series of patients we could not relate the two entities.

Syphilis is also often referred to as a possible etiologic factor in cancer of the vulva but the reasoning underlying this hypothesis may be said to be loose. *Acuminata warts* are also frequently linked with cancer. We have not seen this relationship in our cases and we cannot believe it exists save in those rare instances in which a patient persistently irritates the wart by picking and fissuring it. We have encountered what at first sight seemed to be a multiple (condylomatous) wart (papilloma) which recurred after removal in another clinic and which undoubtedly was a papillary squamous cell carcinoma from the outset. A biopsy would have disclosed the malignant nature of the growth at the first operation (Fig. 429).

PRECANCEROUS LESIONS

On this topic we may speak with more assurance whether we do or do not approve of the term precancerous. There are those who say that a lesion is either cancer or is not cancer and that therefore the term precancerous is a misnomer. No one however can deny that there are lesions which during their course are replaced by or are converted into or induce cancer. In that sense the term precancerous fulfills all the laws of etymology and pathology without violating the proprieties of either speech or pathology.

Just such a lesion is *leukoplakia* of the vulva. Here just as in involvement of the lip, the buccal mucous membrane and the anus a leukoplakia of longer or shorter duration undergoes a malignant degeneration. At the outset leukoplakia is a chronic atrophic inflammation involving the entire vulva or only portions of it so that due to thickening of the epidermis and fibrosis of the underlying derma, the entire skin area or only patches of it take on a blanched parchment-like appearance. In two thirds of all cases the entire vulva from mons veneris to coccyx and including clitoris, prepuce, labia minora, inner surfaces of the labia majora and perineal skin are involved in the process. The disease goes through several stages and presents a typical histopathological picture. Here however our interest centers neither on the symptomatology nor on the pathology of the disease. We are concerned solely with the significance of leukoplakia as a precursor of cancer of the vulva. We find in the literature statements to the effect that leukoplakia develops into cancer in from 50 to 75 per cent of cases and even that it is *invariably* the first stage of cancer. In our series of 63 cases of carcinoma there was a history of pre-

existent leukoplakia in 26. Thus our cases showed a little more than 41.2 per cent of antecedent leukoplakia.

SYMPTOMATOLOGY AND COURSE

Our cases conformed so closely to the classical description of the disease that no purpose would be served by breaking down the data on symptoms into component parts statistically. Since leukoplakia so frequently precedes cancer it is only natural that the earliest symptoms of carcinoma of the vulva should correspond with the symptoms of leukoplakia, namely *itching* (pruritus) or *burning* or both itching and burning which are frequently first noted immediately following urination. After a longer or shorter period of time these symptoms are followed by complaints referable to ulceration of the growth, namely a yellowish dirty *discharge* which at first may not be offensive in odor but which later is almost always offensive. This discharge may be only blood tinged at first but sooner or later it becomes frankly *bloody*. This tendency to bleed is aggravated by trauma such as that inflicted by a douche tip or by intercourse at times this hemorrhage may become massive. At this stage patients not infrequently report having made personal inspections with a hand mirror that disclosed a bleeding sore. Coincident with this *stage of ulceration* the factor of *pain* colors the picture more dramatically. The pain may be localized at first and is usually sharp and lancinating, but if the growth extends downward along the ramus of the pubis it may infiltrate the nerve sheath and be referred subjectively downward to the hip or leg. Difficult and painful urination becomes more pronounced.

As the disease progresses the patient reports a lump in the groin. Indeed she may with incredible stoicism refrain from reporting to her physician until this lump has ulcerated and rendered her an offensive burden to herself and to those in her environment. Meanwhile the *general constitutional symptoms* so characteristic of advancing malignant neoplasms appear including loss of appetite and weight, evidence of anemia and progressive weakness with compromise of respiratory and cardiac functions until finally death intervenes.

TREATMENT

Choice of Treatment—From the point of view of treatment we may generalize broadly by saying that a patient may be subjected to *operative therapy* even if the primary growth be as much as 3 inches in diameter and if it be accompanied by metastatic inguinal lymph nodes provided the nodes in the groin have not become adherent to the skin broken down or ulcerated. Naturally small size of the primary lesions and absence of lymph node involvement give the best prognosis.

When the growth has extended into the vagina, urethra or subpubic space or has infiltrated the entire vulva and extended into the vagina or is accompanied by massive fixed lymph nodes that are in

process of breaking down radical cure is out of the picture. All that can be done for these patients is *palliation* by radiotherapy or cauter, excision plus the administration of sedative and narcotic drugs. It may be said here that radiotherapy except as a palliative measure has no place in the therapy of cancer of the vulva, not even in the earliest and most favorable types of malignant lesions.

Operative Treatment—When one is not forced by inoperable disease to resort to simple methods of surgical palliative measures, the surgical treatment of carcinoma must follow the basic principle that underlies the treatment of cancer anywhere else in the body, namely, an adequately wide excision of the primary growth with the extirpation of all related lymph nodes that are accessible to a surgical approach. This means a wide excision of the vulva plus excision of the

FIVE YEAR RESULTS OF TREATMENT IN CANCER OF THE VULVA

Author	Number of 5 Year Cases	Type of Treatment	5 Year Cures	Percentage of Cures
Taussig	25	Radical operation	16	64
Groge	15	Radical operation	7	46
Reinisch	30	Radical operation plus radiation	12	40
Stoeckl (compilation)	73	Radical operation	26	36
Ruppert	25	Radical operation	9	36
Taussig compilation (Calvin and Kentschler, Granger, Tausch, Tausig)	149	Superficial removal of lymph glands and vulvectomy	24	16
Schneider and Wheeler	72	Radiation	13	18
Bowling	66	Radiation (15 gross dissections in addition)	11	17
Stoeckl (compilation)	126	Palliative alone	15	12
Reinisch (compilation)	382	Unclassified	81	21.2

inguinal and femoral lymph nodes. Only unusually does one see carcinoma of the vulva that is so exclusively limited to one labrum as to warrant the excision of the inguinal and femoral nodes of the corresponding side. As a rule the growth either frankly crosses the midline or so closely approaches it that it becomes necessary to attack the lymph node packets in both groins.

The late Dr. Frederick Taussig, Gynecologist to The Barnard Free Skin and Cancer Hospital, was among the pioneers in the development of the chapter of carcinoma of the vulva in medicine and the principles of treatment that he followed in our hospital are the accepted ones in present use. These principles he has clearly set forth in his book *Diseases of the Vulva*, published by Appleton and Company in 1923. Seventeen years later in 1940 he brought the subject up to

date by his contribution to the second volume of *The Treatment of Cancer and Allied Diseases* by George T Pack and Edward M Livingston published by Paul B Hoeber (page 1783) We refer the reader to these two sources for details of the surgical technic which may be regarded as standard today We may remark in passing however that a mere cursory survey of the accompanying table of post operative results demonstrates that the latest figures show fairly conclusively that a standardized treatment has not yet been adopted universally When we compare these figures with those for carcinoma of the breast for example we note a strikingly wide diversity of results in the reports of different authors If and when the operation of radical vulvectomy is performed with the same consistency of technic that governs the operation of radical mastectomy we may feel assured that the percentage of 5 year cures will not vary within limits as broad as from 36 to 64 per cent, after radical operation

PROGNOSIS

It goes without saying that untreated cases of carcinoma end in death (Fig 430) In the series of 63 cases comprising the patients seen by us from 1925 to 1940 a radical vulvectomy was performed on 40



Fig 430—Ulcerating carcinoma of vulva with lymph node metastasis that later ulcerated resulting in cachexia hemorrhage and death Operative interference contraindicated

patients and a simple vulvectomy was performed on 13 patients Ten were not subjected to operation In the whole series of patients subjected to operation 22 patients survived for 5 years or more making a

5 year survival rate of 41.5 per cent in the whole group of 53 patients subjected to simple and radical vulvectomy. A breakdown of these figures shows that in the series of 40 radical vulvectomies there were 5 postoperative deaths and 18 absolute survivals (i.e. without evidence of disease) for 5 years or more. In the group of 13 patients treated by simple vulvectomy there were 3 postoperative deaths and 4 absolute survivals. Seventeen of the 40 patients undergoing radical vulvectomy died during the 5 year period after operation and 6 of the simple vulvectomy group died in the first 5 year postoperative period. Of these 6 patients 4 showed recurrence of the disease in the inguinal region.

In the series of 40 radical vulvectomies the inguinal nodes were invaded by growth in 22 patients. Fifteen of these 22 showed a unilateral involvement of the inguinal nodes and 7 of them showed a bilateral involvement. Of prognostic significance is the fact that there was a 40 per cent absolute 5 year survival rate in those patients with only a unilateral lymph node involvement whereas there was only a 14 per cent survival rate in those with bilateral lymph node involvement.

CONCLUSION

In conclusion then we may state that carcinoma of the vulva though it may occur at earlier ages is primarily a disease of advanced age. It is frequently preceded by leukoplakia. Pathologically the lesion is squamous cell carcinoma excepting only the rare adenocarcinoma originating in Bartholin's glands. The treatment of choice consists of radical excision of the vulva and the inguinal lymph nodes. With this procedure a prognosis for cure may be offered in nearly 50 per cent of the patients so treated.

CARCINOMA OF THE BODY OF THE UTERUS

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This report is based upon an analysis of 88 cases of carcinoma of the uterus treated at the Barnard Free Skin and Cancer Hospital between the years 1919 and 1936. It is estimated that carcinoma of the uterus is responsible for 30 per cent of all deaths from gynecological disease. Of these over 10 per cent are due to carcinoma of the uterine body. This type of cancer constitutes a distinct group. With few exceptions it is a glandular or adenocarcinoma originating in the uterine endometrium in contrast with the squamous cell carcinoma of the uterine cervix.

INCIDENCE AND ETIOLOGY

Age—Carcinoma of the uterine body occurs most commonly after the menopause, the greatest number of cases appearing between the fifth and sixth decades. Burnam estimates that after the age of 55 corpus cancers are at the least as common as cervical cancers. In the Barnard Free Skin and Cancer Hospital series the average age was 52 and 22 patients had not reached the age of 49. There is no evidence to show that gestation has any relation to the development of corpus carcinoma.

Association with Myomas—Fibromyomas are frequently found in association with carcinoma of the fundus. Stacy reports an incidence of 33.4 per cent of uterine myomas in a series of 269 operated cases. Herli states that the association is a significant one and mentions increased irritation and stasis as possible etiologic factors where there is a pre-disposition to cancer. In the Barnard Free Skin and Cancer Hospital series 35.2 per cent of the operated cases had associated myomas. In 3 of these the carcinoma had not been discovered prior to operation.

It is strongly advised that malignancy of the endometrium be excluded by a careful curettage in every case of myoma associated with irregular bleeding, irrespective of whether the latter be premenopausal or postmenopausal. It is also important that the surgeon who performs a supravaginal hysterectomy for fibroids should inspect the interior of the fundus immediately upon its removal so that the complete operation can be performed if a cancer of the endometrium is present.

Menopausal Relationship—Late menopause is a common observation in women who develop adenocarcinoma of the corpus. Crossen and Hobbs, in reporting a series, found that the incidence of late menopause was four times more frequent in women who developed carcinoma of the fundus. In our series 54.4 per cent were actively

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menstruating at the age of 50 years. In one instance menopause was delayed until 60 years. We believe that a woman who menstruates beyond the age of 50 should be closely observed and the possibility of endometrial malignancy carefully considered. Progress in the conquest of carcinoma of the uterus depends not only upon advances in technique and therapy but upon earlier diagnosis.

Associated Hyperplasia of the Endometrium—The relationship between fundus carcinoma and hyperplasia of the endometrium has been the subject of considerable study and discussion. As pointed out by Martzloff and others, the histologic criteria used by individual pathologists in recognizing hyperplasia is of fundamental importance. This diagnosis should be confined to the cases in which there is definite proliferation of the endometrial elements. We noted adenomyosis of the uterus in 14 per cent of the cases of corpus cancer in our series.

Endometrial hyperplasia becomes a clinically important finding in women over 50 and those who are past the menopause. Payne found the frequency of the association of hyperplasia with carcinoma after the menopause to be 5.8 times that before the menopause. Four of our patients who developed adenocarcinoma had previous curettages with a histological diagnosis of endometrial hyperplasia. Any woman over 50 who has endometrial hyperplasia should be regarded as a potential candidate for the development of carcinoma of the fundus.

DIAGNOSIS

Symptoms—In a large percentage of cases the patient appears to be healthy and well nourished. She is frequently obese and too often her symptoms are attributed to change of life. In 9 per cent of our cases an associated diabetes was present.

Irregular uterine bleeding is the only symptom usually noted by the patient. This is intermittent in character and may be present for weeks at a time. In the premenopausal group *menorrhagia* or *metrorrhagia* may be the only symptoms. In the older age groups the discovery of a *pyometra* is often the first indication that cancer of the fundus is present. Pain is not a prominent symptom although *uterine cramps* may sometimes be present in the early stages due to retained uterine secretions.

Irregular uterine bleeding at the time of menopause or thereafter cannot be temporized with. The indiscriminate use of hormonal therapy for this condition or the employment of radiation without preliminary curettage cannot be too strongly condemned.

Biopsy—The clinical findings are not conclusive and the diagnosis is usually established by a careful diagnostic curettage. Suspicion of malignancy is aroused by an enlarged or softened postmenopausal uterus. On account of the frequent association of fibromyomas and uterine cancer, the sole diagnosis of the former in any woman over 40 should always be regarded with reserve.

The advantages of diagnostic curettage far outweigh its potentialities for harm. This is especially true in those women who may develop carcinoma prior to the menopause. Where the symptoms have been prolonged and where extensive disease is anticipated a course of roentgen therapy may be administered prior to the diagnostic interference.

In our clinic following the example of the Radiumhemmet we endeavor to locate the site and extent of the lesion by performing a fractional curettage in all suspected cases. In this procedure the cervix, lower uterine segment and fundus are curetted separately. The curettings are placed in separate containers. We have discontinued the use of suction biopsy on the grounds of unreliability. We also consider that frozen sections are unreliable as a means of establishing a diagnosis and fraught with hazard to the patient. All the material removed should be thoroughly studied. The pathological report is one of the aids to diagnosis but a negative report cannot be accepted as final in the face of suspicious clinical symptoms.

CLASSIFICATION

Clinical Groups—In order to compare results of treatment various plans of clinical groupings have been suggested. In the nonoperable and radiologically treated group the accuracy of clinical grouping is questionable. Schmitz groups his cases as in carcinoma of the cervix according to the extent of the disease. Healy and Brown list three clinical groups. In the first the uterus is not enlarged, in the second the uterus is enlarged to the size of a 2½ months pregnancy, and in the third the disease has extended beyond the uterus. Heyman stresses the recognition of a special group of cases in which cancer can be demonstrated anatomically and histologically in both corpus and endocervix. He applies the term *carcinoma corpus et collum* to this type of lesion and classifies it separately under this heading. He states that the possibility of comparing different statistics on corpus cancer will be entirely ruined if one clinic places these with the corpus cancers and another with the cervical cancers. We have adopted Heyman's classification regarding this type of lesion in the Barnard Free Skin and Cancer Hospital clinical records.

Grade of Malignancy—Many pathologists have stated that carcinoma of the body of the uterus occurs in several distinct varieties or grades but frequently one finds different histological patterns in the same uterus. Mahle, Lindsay, Healy and Cutler claim that a definite relationship exists between histologic structure, grade of malignancy and sensitivity to radiation, which has an important bearing on the end results. Our laboratory does not attempt to set up grading based solely on microscopic histopathology but does recognize two groups which can be identified histologically—the adenoma malignum group and the adenocarcinoma group. In the adenoma malignum group the

tumor is well differentiated superficial in character and tends to remain localized in the uterus. The grade of malignancy is low and although the lesion is not relatively a radiosensitive one it responds well to radium therapy. The percentage of cures is high, irrespective of the type of treatment employed.

In the adenocarcinoma group the tumor cells are undifferentiated very anaplastic and invade the stroma. The lesion is very malignant and metastasizes early. It is highly radiosensitive and the results obtained with irradiation whether or not combined with surgery are far better than when surgery alone is employed. The cases are about equally divided between these two groups.

METASTASIS

Metastases tend to remain regional in corpus cancer. Endometrial emboli may account for involvement of the tubes and pelvic peritoneum. Metastasis to the ovaries and lymph glands occurs through the lymphatic system. The bones and lungs can become secondarily involved via the blood stream. Gravity implants may spread the disease to the cervix or the vagina. The cancer frequently invades the uterine wall and penetrates to the serosa and adjacent organs.

It sometimes happens that viable cancer cells are squeezed through the tubes or spilled into the operative field during the performance of a hysterectomy. Behner cites 2 operative cases where groups of cancer cells had been pumped into the tubes and cul de sac respectively in the course of inserting a radium capsule through an inadequately dilated cervix.

It follows that certain precautions are indicated when an operation for carcinoma of the corpus is performed. The cervical canal should be packed with a small gauze pack and the external os closed by suture. In vaginal hysterectomies we circumsise the cervix an inch above the external os and bring down an occluding flap of mucosa. When the abdomen is opened the fimbriated ends of the tubes should be immediately clamped to prevent any spill. No form of tenaculum should be used for traction on the uterus and the latter should be handled as gently as possible during the operation.

When the vaginal vault is amputated a cautery knife should be used and the vaginal cuff carefully clamped off above the line of incision. If contamination is suspected a course of deep x-ray therapy should be administered postoperatively to the vaginal vault and pelvis.

TREATMENT

Each patient with carcinoma of the corpus presents an individual problem. No standardized plan of therapy can be offered because irrespective of the type of treatment the ultimate prognosis depends upon a number of clinical factors which must be carefully evaluated.

These include the age and general condition of the patient the duration of the symptoms prior to diagnosis the extent of the disease and the histological pattern of the lesion

In well differentiated lesions confined to the endometrium a *simple panhysterectomy* constitutes an adequate therapeutic procedure The reported results however vary considerably and as Healy points out One is impressed by the evidence that panhysterectomy has failed to give a 5 year cure rate above 50 per cent in the majority of leading cancer clinics The practical difficulties experienced in making a positive clinical and pathological diagnosis and the part played by hysterectomy in accelerating metastasis must be taken into consideration The protection afforded by the uterine wall and the accessibility of an endometrial carcinoma render it possible to administer concentrated doses of radiation to this lesion without undue risk to the patient In about a third of the patients presenting themselves for treatment radiation is the only form of therapy that can be considered justifiable

In the Barnard Free Skin and Cancer Hospital we believe that better results will be obtained by *combining surgery with preliminary irradiation* A course of deep x ray therapy is administered following which an intra uterine application of radium element is made The uterus is then removed if surgically feasible within 2 to 4 weeks of the radium treatment In an effort to administer a homogeneous radiation the method advocated by Heyman and introduced by Arneson is used In this the uterus is packed with a number of capsules of weak strength varying from 2 to 10 mg The calculated dose is administered in one treatment and varies with the conditions present It usually does not exceed 3600 mg hours Where surgery is not contemplated the dose is considerably augmented and a curettage is frequently done within a year in order to exclude persistent disease

Results—The results are calculated on the basis of 10 5 and 3 year survivals In the Barnard Free Skin and Cancer Hospital series the poorest results were in the cases with cervical involvement although a majority of these were not advanced cases In the inoperable group no patient survived 10 years 20 per cent survived 5 years and 25 per cent showed no evidence of disease 3 years after treatment In the operable group a 10 year survival rate of 67.7 per cent was obtained Improvement in results can be chiefly effected by earlier diagnosis The majority of malignant tumors are discovered by alert physicians and the responsibility for improvement lies not with the specialist but with the general practitioner

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THE DIAGNOSIS AND TREATMENT OF CERVICAL CANCER

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EXPERIENCE and observation in the treatment of carcinoma of the cervix at Barnard Free Skin and Cancer Hospital over a period of 15 years form the basis of a study on present day methods of diagnosis and treatment of such a widespread disease. The gynecological department has seen over this period of years approximately 1000 cases of cancer of the cervix the disease constituting over 80 per cent of the hospital admissions on this service.

PATHOLOGY

Squamous cell carcinoma of the cervix begins as a small circumscribed lesion at the external os and by rapid and limitless proliferation of its cells spreads in three directions outward into the lumen of the vagina sidewise over the rest of the vaginal portion of the cervix inward into tissue of the cervix. The outward or *extending* growth produces a conglomeration of high papillary structures composed in the main of masses of epithelial cells which are feebly supported by delicate connective tissue fibers but richly supported with blood vessels. The slender fingerlike processes anastomose freely with one another by means of the proliferating cells thus forming a solid new growth (Fig 431). By lateral extension over the remaining outer surface of the cervix the new growth increases in bulk and at the same time its cells invade the underlying tissue of the cervix destroying the normal cells in their path and firmly anchoring the neoplasm in foreign territory. Eventually the tumor may attain a very considerable size and fill the upper half of the vagina completely.

DIAGNOSIS

Signs and Symptoms.—The malignant changes here described in brief may go on for quite some time without giving any outward signs of their existence. The patient feels perfectly well and there is at first only a slight serous transudation hardly enough to attract the attention of any except the most fastidious woman. The first danger signal comes in the form of a slight tinge of blood in the heretofore clear secretion from the vagina. The cancer cells may have eroded capillaries in the delicate papillary projections which constitute the tumor. More often the scant admixture of blood is due to trauma.

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There is frequent occasion for injury in the vagina. The passage of constipated stools, the heat of a vaginal douche, the touch of the douche nozzle or of the penis in intercourse will suffice to break off some of the slender stems of the growth, and even a slight rise of blood pressure incident to lifting a burden will be enough to burst a blood vessel in the tumor—all traumatism which normal tissue could easily withstand. The amount and duration of bleeding will then merely depend on the size and number of blood vessels which have thus been opened. A sharp hemorrhage may therefore occur now and then but without predictable regularity. Such profuse bleedings have no relationship whatever to the menstrual period, a most significant diagnostic sign which stands in marked contrast to the fairly regular



Fig. 431—Squamous cell carcinoma of the cervix ($\times 130$)

hemorrhages caused by fibroids. The most important early sign in carcinoma of the cervix is *abnormal vaginal bleeding*. Because our patients are indigent, in the earliest cases seen here the patients have not sought medical care until they have experienced abnormal bleeding for a period of 4½ to 6 months. The onset of leukorrhea or the change of a moderate nontroublesome vaginal discharge to a foul profuse flow are fairly common signs that are too frequently disregarded.

Inspection and Palpation.—If a digital examination is made while the tumor is still intact, the finger feels a mass springing from the cervix, presenting an irregular surface which looks and feels like a cauliflower. The first sensation to the touch is that of hardness except on the very surface which seems rather soft. This hardness is deceptive for

the finger can penetrate without much force deeply into the tumor and gouge out large pieces of tissue. Rarely is the cauliflower growth intact. Superficial destruction of the surface has taken place; septic and saprophytic bacteria have effected an entrance and have led to infection and necrosis with widespread disintegration of the tumor. The result is the formation of a crater with a sloughing base which exudes a dirty brownish gray offensive discharge.

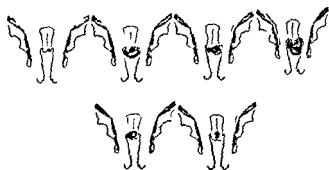


Fig. 437—Adenocarcinoma of the cervix ($\times 130$)

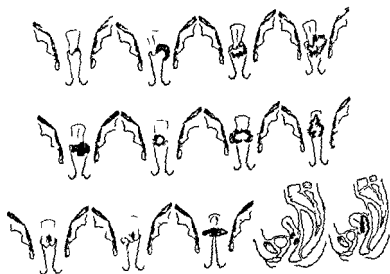
In some cases the everted type of growth is absent from the beginning and only the inverting tendency of growth is in evidence. These are the cases where the cancer develops on the basis of an erosion. The characteristic feature is then the formation of an ulcer which in its further development undergoes changes which are similar to those described for the cauliflower growth.

In contrast to the distinctly visible and palpable *squamous cell cancer* of the cervix which because of its exposed location presents danger signals at a comparatively early stage the *adenocarcinoma* hidden as it is within the cervical canal escapes detection for a long

time (Fig. 432) Here the cylindrical epithelium developing malignant characteristics penetrates deeply into the substance of the cervix before increased secretion and hemorrhages may attract attention The external os may long remain intact and the normal appearance of the small round opening of nulliparous women or the slitlike os of multiparous



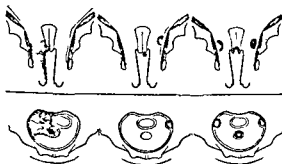
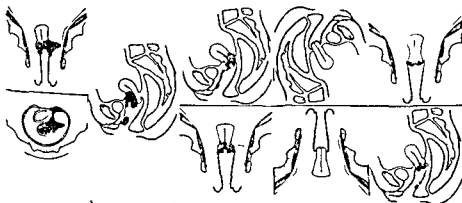
STAGE I



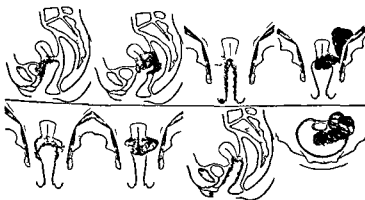
STAGE II

Fig. 433—Clinical pictures of carcinoma of the cervix. Carcinoma of the cervix. The Le gues of Nations

parous patients may deceive the examiner. The introduction of a sound into the cervical canal reveals a cavity of at times, surprising extent. On bimanual examination and particularly by recto-abdominal palpation the ballooning of the cervix leads to the right diagnosis. Because of the insidious growth of adenocarcinoma of the cervix and because this tumor is less radiosensitive than squamous cell lesions the pro-



STAGE III

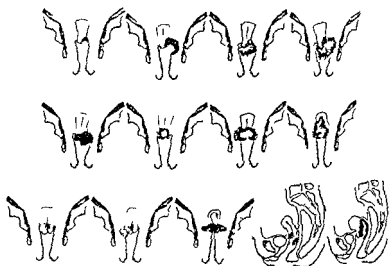


STAGE IV

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STAGE II

Fig. 431—Clinical picture of carcinoma of the cervix (as published in the Bulletin of the League of Nations)

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Stage I

- 1 The carcinoma is strictly confined to the cervix

Stage II

- 1 The carcinoma infiltrates the parametrium on one or both sides but has not invaded the pelvic wall
- 2 The carcinoma infiltrates the vagina but does not involve its lower third
- 3 Endocervical carcinoma which has spread to the corpus

Stage III

- 1 The carcinomatous infiltration of the parametrium has invaded the pelvic wall on one or both sides. On rectal examination no cancer free space is found between the tumor and the pelvic wall
- 2 The carcinoma involves the lower third of the vagina
- 3 Isolated carcinomatous metastasis are palpable on the pelvic wall (irrespective of the extent of the primary cervical growth)

Stage IV

- 1 The carcinoma involves the bladder as determined by cystoscopic examination or by the presence of a vesico vaginal fistula
- 2 The carcinoma involves the rectum
- 3 The carcinoma has spread outside the true pelvis (below the vaginal inlet above the pelvic brim distant metastasis)

TREATMENT

Röntgen Therapy—The diagnosis having been made and the clinical grouping agreed upon the patient is immediately referred to the Department of Radiotherapy under the direction of Dr Edwin C Ernst. In all cases in which radiation (γ ray and radium) is to be the sole method of treatment a calculated dose of 2500 roentgens to the site of the tumor is administered. This dose is the amount of radiation delivered at the depth of the tumor with a 200 kv 18 ma machine at a distance of 50 cm and using a filter of Thoraeus. This computation was made by Drs Ernst and D J Verda on a series of patients and on a masonite phantom by the actual measurement of the number of roentgens delivered at the depth of the tumor with an ionometer inserted to the cervix through the vagina. Charts were made from these observations and by their use the amount of radiation that can be delivered to the site of the tumor through a given port may be readily determined. In small individuals 4 ports 2 anterior and 2 posterior usually suffice while in extremely large individuals 6 ports including a perineal port are sometimes necessary. This dose is administered in units of 250 roentgens per port using two ports a day. When radical surgery is contemplated only a half dose of γ ray is given as it is felt that this amount of radiation reduces the activity of the tumor and the infection in it and yet does not increase operating difficulties nor slow down wound healing as does the larger dose.

Surgery—Upon the completion of the prescribed γ ray therapy the patient is admitted to the hospital after an interval of three weeks. The treatment of stage I and of the more advanced groups differs in that we prefer radical abdominal hysterectomy for the early cases but

regard surgery for the more advanced cases as contraindicated. The principle of the radical abdominal operation consists in the removal of the entire uterus with a good portion of the upper vagina the entire surrounding connective tissue containing the lymph vessels of the uterus and at times the regional nodes. The ureter is dissected out to protect it from injury during the excision of the parametria. The ureter is not however stripped of its nutrient vessels. If the ureter is stripped a high incidence of ureteral fistula will follow.

Originally it was thought that the removal of the parametria was not as important as the excision of the lymph nodes because the lymph vessels served only to transport but not to hold the carcinoma while the nodes were the lodging place of the disseminated disease. We know that metastases to lymph nodes occurs frequently in carcinoma of the cervix. In stage I cases there is involvement of the regional nodes in one fifth to one tenth of the cases in stage II cases metastatic nodes are found in one third to one half of the patients and in cases with infiltration of the parametria to the pelvic wall node metastases are found in about 64 per cent of such patients. The hope of improving the end results by removal of the lymph nodes is questionable. Further investigation is being done in this clinic to determine the efficacy of iliac lymphadenectomy.

Schauta believed that malignant cells are either destroyed in the lymph nodes or that they assume a latent stage of long duration. He was able to demonstrate lymph node metastases in 70 to 40 per cent of his operated cases. He believed that a radical removal of the involved nodes was rarely possible or successful because the aortic group of nodes which are inaccessible surgically became involved at about the same stage of the disease as the surgically accessible iliac group of nodes. He also recognized the fact that a block dissection of this area could not be done and that inevitably malignant tissue would be left behind in a dissection of this area. Wertheim also held the same view when he wrote the extirpation of lymph glands can contribute nothing toward the improvement of the end results.

In our recent study of cases followed 5 years or more between the years of 1928 and 1938 141 stage I proven cases of squamous cell carcinoma of the cervix which were treated with radical abdominal hysterectomy were found. In a few of these patients removal of the iliac nodes was accomplished but in most of them a node dissection was not attempted. There were 6 postoperative deaths in this group all but 1 from peritonitis. Of the surviving 35 cases 1 patient had a recurrence in 2 years 1 died of other causes at the end of 2½ years without evidence of recurrence and 33 were alive and free of the disease 5 years or more following the operation. In recent years the use of sulfonamides has reduced the incidence of peritonitis and when it does occur improved methods of combating the infection have considerably reduced the mortality. Since 1938 18 additional radical ab-

dominal hysterectomies were performed for squamous cell carcinoma with 1 operative death an operative mortality of 6 per cent. In all there were 63 of these operations performed since 1928 with 7 post operative deaths an operative mortality of 11 per cent. These excellent results should be credited to the late Dr. Fred J. Taussig who performed or supervised most of these procedures.

The absolute survival rate of 5 years or more without evidence of cancer for stage I cases having radical abdominal hysterectomy was 83 per cent as compared with 60 per cent for 27 proved cases of stage I carcinoma of the cervix treated with a full dose of x-ray plus radium.

As stated before radical abdominal hysterectomy for carcinoma of the cervix is limited to stage I and to those patients who are excellent surgical risks because of age and general physical condition. The patient should have an apparent survival of at least 10 to 15 years after the operation. There should be no active infection of the cervix or in the vagina. The individual past 50 years, the nephritic, cardiovascular, obese or extremely anemic patient is not suitable for this type of surgery.

Preparation of Patient—For a week before the operation the patient is instructed to use 1:8000 potassium permanganate douches twice a day and on the preoperative day zephiran instillations are given morning and evening. The patient's blood is typed and cross matched and arrangements are made to have a blood donor available during the operation. In the operating room vaginal preparation using 3 per cent iodine and alcohol is used and the bladder catheterized. The patient is then turned on her side and a spinal anesthetic is administered using novocain 200 mg.

Radical Abdominal Hysterectomy—After the abdominal preparation the abdomen is opened through a suprapubic midline incision. The peritoneal cavity is carefully explored and parametria felt for infiltration. Enough time has now elapsed since the administration of the spinal anesthetic to make it safe to place the patient in a fairly deep Trendelenburg position. The intestines and omentum are packed back with the Gellhorn rubber sheet and the pelvic organs exposed. The right infundibulopelvic ligament is clamped, cut and secured with a suture as is the right round ligament about 4 cm. from the uterus. The same procedure is carried out on the opposite side. The leaves of the broad ligament are separated and the reflection of the peritoneum of the bladder is incised. By blunt dissection staying snugly against the uterus and cervix the bladder is reflected to a point well below the cervix usually about 4 cm. The leaves of the broad ligament are further separated and the ureter identified clinging to the posterior leaf of the broad ligament. It is dissected free so that its entire course through the operative field can be visualized. The uterine vessels are readily identified, secured and cut about 2 cm. from their origin. Posteriorly the dissection is carried down close to the rectum to a point

well below the cervix. Protecting the ureter, the leaves of the broad ligament are cut widely, and then after clamping and cutting the parametrium, the vagina is approached laterally. Suture ligatures then replace the clamps. The same procedure is carried out on the other side.

The vagina is opened and an adequate cuff of the vagina is removed with the uterus. The distal edges of the vagina are held with Allis clamps, a Y drain is inserted into it, and the vagina is closed loosely about the drain. Sulfanilamide powder is sprinkled over the raw surfaces, and the peritoneum over the pelvic floor is brought together with a running cutgut suture. The round and infundibulopelvic ligaments are caught with a suture and approximated to the lateral edges of the vagina for support. Additional sulfanilamide powder is used in the peritoneal cavity, and the abdominal wall is closed in layers. The procedure seldom results in shock. The most dangerous complication that we have encountered in the past has been infection, which is combated with the sulfa drugs and supportive measures.

Other Surgical Methods—Other surgical methods were employed in this clinic during the period studied. The *radical vaginal hysterectomy* under local anaesthesia was used by the late Dr. George Gellhorn on 17 cases with a salvage of 75 per cent after 5 or more years. At that time the recognized lower mortality of the *Schauta radical vaginal hysterectomy* was considered. This operation permitted as extensive an excision of the parametria and vagina as can be made by the abdominal approach. An accurate removal of nodes cannot be performed by this route, but since the success in operating for cervical carcinoma lies in the most radical possible excision of the parametria and vagina, the removal of the nodes comes less into consideration. *Simple vaginal hysterectomy* was performed in 10 cases. In the majority of these cases the malignancy was an early one on a prolapsed cervix (Fig. 434) but in two cases the malignancy was unsuspected until the specimen was examined following operation. The survival rate in this group was 90 per cent.

Radium Implantation in Poor Operative Risks—If the patient is deemed a poor operative risk, operation is not attempted, further treatment consisting of radium implantation. A method of radium implantation which has proved quite satisfactory has been introduced in this hospital by Dr. A. N. Arneson, and has been found readily adaptable to almost all of the variations of all stages I through IV. It is our desire to administer to the tumor at one time a dose between 5000 and 6000 mg. hours, well filtered and well distributed. This procedure can usually be adequately done under twilight anaesthesia. The uterus is sounded and the cervix os dilated so that it will accommodate a brass capsule which contains in tandem three 25 mg. needles in 0.5 mm. of platinum. A piece of sponge rubber is then trimmed so that it will fit snugly up against the cervix. In the ordinary case two 75 mg. needles in 1 mm. of platinum are embedded in the sponge rubber in such a

manner that one needle will fit snugly up into each lateral fornix and an additional 10 mg needle in 1 mm of platinum is inserted in the sponge rubber in such a manner that it will lie across the area of greatest involvement. The sponge rubber is then placed against the cervix so that the contained radium is in the desired relation to the surrounding structures. The elasticity of the rubber keeps the vagina expanded thus providing distance. The snug fit of the rubber enables the position of the implant to be maintained. Stout threads are fastened to all radium needles and these threads are tied to a vaginal pack which is inserted over, under and behind the sponge rubber applicator in

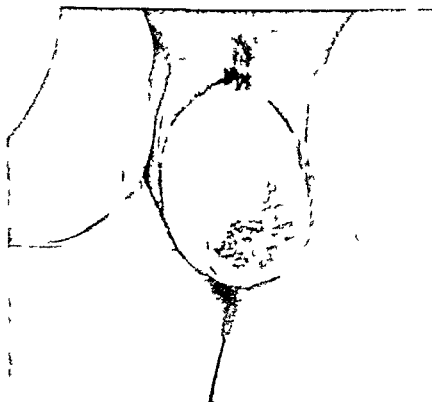


Fig. 434—Carcinoma on a prolapsed cervix

creasing the distance of the radium from the bladder, rectum and vaginal walls and holding the applicator firmly in place. One of the advantages of the sponge rubber technique for implanting the radium is that the distribution of the radium can be highly individualized to meet the requirements of different cases. This method of radium implantation has resulted in a 38 per cent survival rate for 47 stage II cases so treated from 1936 to 1938.

We feel rather strongly that a full dose of radium should be given in every case for which radium is prescribed. A few patients were treated with smaller doses because the apparent involvement was slight and because both the response to α radiation and the microscopic appear

ance of the lesion indicated a radiosensitive tumor. In the patients so treated there was unfortunately a high recurrence rate.

Operative Procedures for Advanced Stages—Operative procedures have also been employed in the treatment of stage II carcinoma of the cervix but they have not been generally accorded favor. Most important of these in this clinic has been the *Taussig iliac lymphadenectomy*. Dr. Taussig's plan consisted of following a full course of x-ray by a resection of as much as possible of the lymphatic tissue about the iliac bifurcation, obturator space and the external iliac vessels. Two weeks after the operation a full dose of radium was given. Early results tended to show that this method would increase the survivals in stage II lesions. More recent investigation with a follow-up of the 72 cases so treated between 1928 and 1938 show no significant difference between this group and cases treated with radiation alone. There were 3 operative deaths in this series. Twenty-nine patients had positive lymph nodes removed and of this latter group only 3 were alive and well 5 years after the operation. One of these 3 had in addition to the gland dissection the intra-abdominal implantation of radon seeds.

Other operative procedures for stage II cancer of the cervix have been attempted. *Radical abdominal hysterectomy* and the *radical Schauta vaginal hysterectomy* were performed in a few cases. Two of the 4 patients who underwent radical abdominal hysterectomies survived 5 years or more without recurrence as did 5 of the 8 who were given the Schauta operations. These were very early stage II cases.

Radium Implantation in Advanced Cases—There were 14 cases in which intra-abdominal implantation of radon seeds was used beneath the peritoneum in such a way that they formed a complete ring around the periphery of the cancerous area. Particular attention was given to the iliac triangle with its nodes, the vesicovaginal septum, the sacro-uterine ligaments and the small node between the ureter and uterine artery. These cases were not early and out of the 14 patients 4 lived 5 years or more. This procedure was tried in 7 stage III cases and 1 patient survived.

Our results with advanced cases of cervical carcinoma are extremely disappointing. Only 5 per cent of 250 stage III cases seen here between 1928 and 1938 of which approximately 220 completed the prescribed course of therapy survived five years or more.

SUMMARY

The treatment of cancer of the cervix leaves much to be desired. Our success with early cases holds out a plea for an earlier diagnosis. While the immediate mortality following radiation treatment is considerably less than that following hysterectomy, the late complications often leading to death are definitely more frequent. In stage I cancers radical surgery in patients who are good operative risks presents definite advantages over radiation. In stage II cancers radical surgery gives

too high a primary mortality hence radiation of the primary lesion is advisable. We are not prepared to say at this time whether radiation combined with the removal of the individual iliac glands will increase the survival rate. In stage III and stage IV cancers radiation is the only means of treatment.

Further observations will be necessary to establish the ideal methods of treatment in each individual case.

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PRESENT CONCEPTS ON THE TREATMENT OF CARCINOMA OF THE PROSTATE

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In the spring of 1941 Huggins, Stevens and Hodges reported their experiences in the treatment of prostatic carcinoma by castration. It is the purpose of this paper to present the scientific basis for the choice of treatment and to review briefly the effects of the various therapeutic procedures.

BACKGROUND

The observation which through correlation with many others eventually leads to the modern treatment of carcinoma of the prostate was first made several centuries ago. Some time in the dim past probably first by accident man noted that removal of the testes was followed by certain distinctive changes. In animals there was a tendency to become more obese and less active. In chickens there was atrophy of the comb and wattles so characteristic of the rooster. In man if castration was carried out before puberty there resulted a person with little or no sexual drive. It is hardly necessary to point out that this was the basis for the use of eunuchs in the harems of Turkey and China.

With the development of scientific inquiry in the eighteenth and nineteenth centuries efforts were made to study in more detail the effects of castration. One effect present in all animal species is atrophy of the prostate. After removal of the testes the prostate decreases progressively in size until no more than a slight thickening and induration about the urethra can be palpated by rectum. Microscopic study reveals a decrease in the size of the acini and a change of the normal columnar cell to a cuboidal or flat type.

This distinctive fact—atrophy of the prostate on castration—lay on fallow ground until the discovery of the so called sex hormones about 1930 except for the utilization of it for a short period between 1850 and 1900 in the treatment of nodular hyperplasia of the prostate.

Effect of Androgens on the Prostate—Injection of most types of androgenic substances leads to hypertrophy and hyperplasia of the prostate. In the normal animal there is an increase in the height of the epithelium and in the castrated animal a restoration of the epithelium to the normal and an increase in the size of the entire gland.

Effect of Estrogens on the Prostate—Contrarily estrogens cause atrophy of the prostate and metaplasia of the epithelium of the ducts.

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to a transitional or squamous type. Estrogens also elicit a specific response in certain structures of the male organism derived from the müllerian ducts: the prostatic utricle, the epithelium over the verumontanum and the appendix testis. The epithelium of these responds by squamous metaplasia and keratinization.

Neutralization of Androgens by Estrogens—If both androgen and estrogen be injected in proper proportions the effect of the androgen is not elicited. This neutralization is observed when the ratio by weight of androgen to estrogen is about 50 to 1. With less androgen there is an estrogenic effect and with more androgen there is an androgenic effect.

Phosphatase and the Prostate—In the 1920's it was noted that the urine contained a relatively large amount of an enzyme capable of hydrolyzing organic phosphates at a pH of about 5.0. Little further investigation was needed to demonstrate that the source of the phosphatase was largely prostatic secretion.

Phosphatase in Prostatic Carcinoma—In a systematic study of the acid phosphatase activity of the blood it was noted that most patients with prostatic carcinoma showed increased values up to 1000 units (Gutman and Gutman).

The development of a method for the staining of phosphatase in tissue sections by Gomori allowed a more minute study of the enzyme in relation to cellular structure. Normal epithelial cells of the prostate contain large amounts of acid phosphatase which decreases on castration. Furthermore the neoplastic cells of prostatic carcinoma are rich in acid phosphatase.

Conclusions—Here are the facts. How may we reason with them? The cells of prostatic carcinoma resemble the normal cells physiologically in containing acid phosphatase. The normal cells will undergo atrophy if the androgen from the testes is withdrawn by castration or neutralized by estrogen. What would be the effect of decreasing the effective androgen on carcinoma? It is to the credit of Charles Huggins that he saw his logical question, tried the procedure and succeeded.

TYPES OF THERAPY

The observations presented in the preceding section indicate that depression of the effective androgenic stimulation to the prostate might be beneficial in the treatment of carcinoma of this gland. There are available today three basic procedures to lower or block the androgens: relative inactivation of the testes by radiant energy, removal of the source of testicular androgen by castration and neutralization of androgen by administration of estrogen.

Although a few still favor irradiation, most urologists use castration or therapy with estrogens or both. Of the estrogens, diethylstilbestrol and the propionate ester have been most widely employed in doses of 1 to 5 mg. by mouth three times a week. A few who use the combined

treatment administer larger doses—10 mg per day for 5 to 10 days—in order to secure a rapid effect in the first weeks after castration

RESPONSE

The response in carcinoma of the prostate to lowering of the effective androgen by any of the three procedures has been little short of amazing in three quarters of the patients. For clarity the discussion will be presented under four titles: effects observed clinically; effects on laboratory tests; effects observed radiographically; and effects observed anatomically.

Effects Observed Clinically—Within a few days the patient who has had intractable pain for weeks or months is greatly relieved. The pain of bony metastases is no longer disturbing; the appetite improves and there is at least some sense of well being, reaching a maximum benefit in from 2 to 8 weeks. The weight increases and as much as 50 pounds is gained in from 6 to 9 months. Edema, if it has been present, disappears.

The prostate decreases progressively in size and becomes somewhat softer. The patient who was unable to void because of prostatic obstruction of the urethra can again empty his bladder. Any sexual drive which was present is lost and some symptoms of the climacterium may become evident, especially hot flashes. However, control of them is usually accomplished by the administration of 1 mg of stilbestrol daily.

In patients treated with estrogens the side effects are apparent but not disturbing. A few complain of nausea, anorexia, tenderness of the breasts, and atrophy of the testes.

Effects on Laboratory Tests—There is a precipitous fall in the acid phosphatase in the blood so that within a week there is an approach to the normal. The alkaline phosphatase usually increases for some weeks and then falls to the pretreatment level or lower.

If an anemia were present a slow restoration to normal is seen in 1 to 5 months after beginning treatment.

The effect on the urinary excretion of hormones depends on the procedure used. With castration the urinary estrogen falls to 10 per cent of normal; the urinary 17 ketosteroids increase to values as much as 100 per cent above normal; and the gonadotropin increases slightly. With estrogens the urinary 17 ketosteroids decrease.

Effects Observed Roentgenographically—In most patients there is little observable change in the bony metastases. In fact there is slowly progressive growth. However, in a few patients the metastatic deposits gradually decrease in size and so far as can be demonstrated in the roentgenogram disappear. Similar resolution of metastases in the lymph nodes has been observed.

Effects Observed Anatomically—Not only is there clinical improvement but the structure of the neoplastic cells is altered. In patients

treated with diethylstilbestrol Schenken Burns and Kahle describe the process of involution as follows The first stage of regression shows a decrease in the size of the nuclei and condensation of the nuclear chromatin Nucleoli are no longer visible and mitoses are absent The cytoplasmic vacuoles are located predominantly at the base of the cells The nuclei in the second stage are pyknotic The cytoplasm is practically clear and the cell membranes have ruptured resulting in the coalescence of the vacuoles With the rupture of all the cell membranes the pyknotic nuclei and cell membrane fragments are clustered in the acinar space The end stage is represented by the clear acinar space containing only remnants of pyknotic nuclei My own limited observations are entirely in accord with these careful studies of Schenken Burns and Kahle

OUTLOOK FOR THE FUTURE

Only 4 years have elapsed since the more intensive study of this problem was begun There is general agreement that 75 to 85 per cent of patients who undergo castration for carcinoma of the prostate are definitely improved for some period of time As expressed by one author the responses in a period up to a year are without precedent in the large experience of this clinic Some report that after 1 to 2 years 50 per cent show progressive growth of the neoplasm despite energetic treatment with estrogens The other 50 per cent are still improved

The answer to the question what will be the situation after 8 or 10 years is probably given in the report of Randall who in the early 1930s on empirical grounds castrated 5 patients who had advanced carcinoma of the prostate None were cured but with all life became again worth while Regardless of the ultimate fate of the cancer it is clear that one of the prime functions of the physician is accomplished by the modern treatment of prostatic carcinoma—alleviation of pain and restoration of the person to a reasonably comfortable life

QUESTIONS AND INTERPRETATION

Every experience in medicine and science whether it be in the laboratory or in the hospital is capable of contributing basic knowledge The simple fact that the clinical symptoms the anatomic appearances and the biochemical relations of prostatic cancer are altered after castration and after administration of estrogens gives us another tool to study cancer

Why is it that some patients respond and others do not? Are there at least two types of prostatic carcinoma one susceptible to the influence of a testicular hormone and the other not? Some suggest that adenocarcinoma responds better than undifferentiated cancer Can some physiologic or anatomic test be developed to predict which patient will respond?

Why is it that some patients are temporarily improved and then have a relapse? Are there stages in the development of a malignant tumor in which the first stage is not fully autonomous? If this is so then we should seek some other form of therapy to prevent full autonomy while the first stage is under temporary control by castration or hyperestrinism. Studies of mammary carcinoma in the rabbit by Greene indicate that there are two stages.

Why is it that equally good results are secured with castration after which there is an increase of urinary 17 ketosteroids and with estrogens after which there is a decrease of the same steroids? Perhaps the urinary 17 ketosteroids are not a reliable index of the effective androgenic stimulation in the body. On the other hand it may be that the actual steroid in the urine in the two instances is not the same.

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COMBINED SURGICAL AND HORMONAL TREATMENT FOR CANCER OF THE PROSTATE

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THE urologist's responsibility in each case of cancer of the prostate is to diagnose the tumor from the standpoint of its probable duration its size and shape degree of involvement and its effect upon the urinary tract and general health. These facts at once establish the initial therapy indicated. Prior to the work of Charles Huggins¹ we could use as a possible cure Hugh H. Young's radical perineal prostatectomy. As palliative measures we had x-ray or radium or implant of radon seeds partial removal of the prostate either by the suprapubic or perineal method retention or intermittent catheterization or permanent suprapubic cystostomy. Later we had transurethral resection of the prostate which superseded all other surgical methods for relief of the urinary obstruction when total removal of the cancer was impossible.

Since 1941 we have added castration or the therapeutic administration of an ovarian hormone (Huggins¹ Herbst) to our armamentarium. The basis of these procedures is that adult prostatic epithelium undergoes atrophy when the male hormones (androgens) are greatly reduced by castration or neutralized or inactivated by the administration of a female hormone (estrogen). The synthetic product diethylstilbestrol[†] is used exclusively in the following reports.

The work initiated by Huggins in 1941 has been of great value but at this time we should not accept it as *the only* approach to the treatment of prostatic cancer. The old established surgical palliative and x-ray therapeutic procedures still are useful often in combination with the newer methods.

PATHOLOGY

There are many pathologic variations in cancer of the prostate. Microscopically we find either sheets of cancer cells or more commonly the cancer cells form the imperfect tubules which distinguish an adenocarcinoma. The growth may spread or grow locally either rapidly or slowly. The small cancer of the prostate which metastasizes early is called an occult cancer by R. A. Moore.² It presents special diagnostic problems. The most positive point may be the appearance of metastases in the lower spine the pelvis or the femur. Examination by rectum discloses a prostate that is large or small soft or hard. Fixation and local

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[†]The terms diethylstilbestrol and stilbestrol are used interchangeably in this article.

induration are the cardinal points yet a local area of scar tissue or prostatic calculi may suggest carcinoma. If carcinoma is suspected weekly re-examination by rectal palpation will usually bring out the local change and suggest the diagnosis. The large hard irregular mass is easily diagnosed. Spread to the intravesicular area to the capsule and to the membranous urethra should be noted.

DIAGNOSIS

Blood Serum Phosphatase Tests—Acid and alkaline phosphatase findings do not in a large percentage of cases bear any relation to the clinical findings or to cancer control. An acid phosphatase above 4.5 King Armstrong units however is very suggestive of the presence of cancer particularly if rectal palpation suggests cancer and no other disease is present. An acid phosphatase above 10 units is pathognomonic. There are no false positives but false negatives do occur that is we may have metastatic cancer with a blood serum acid phosphatase below 10 units and even an alkaline phosphatase not suggestive of bone metastasis. When lymphatic tissue or bone marrow is involved the acid phosphatase has entrance into the blood serum. The enzyme is elaborated by *adult* prostatic epithelium. Alkaline phosphatase is produced by *bone osteoblastic reaction* and its rise signifies bone involvement. The normal figure is about 8 Bodansky units. Phosphatase reaction is an enzyme reaction that is the enzyme enters into a reaction without itself being changed. The acid and the alkaline phosphatase are *expected to be reduced* by removing (castration) or neutralizing (stilbestrol) the stimulating male hormone (androgen) elaborated by the testicle.

Biopsy Palpation and X ray—So far no instrument is over 60 to 75 per cent successful in securing an adequate specimen for biopsy and occasionally even though biopsy material is obtained there may be insufficient tissue for a satisfactory pathological diagnosis. Aspiration biopsy comes far from solving the problem. Recently I have used a screw biopsy instrument with greater success than with previous instruments. It consists of a trocar (the tube having long cutting teeth) which fits a sharp obturator so that it is easily passed through the perineum and down to the area from which a biopsy is desired. The sharp pointed obturator is then replaced by a sharp edged screw obturator with a plug. This is screwed into the area of suspicious prostatic tissue which is thus forced into the hollow screw obturator. Other biopsy instruments used in the past always hooked out prostatic tissue.

Rectal palpation gives an 80 per cent accurate diagnosis.

X ray films are useful in differentiating metastatic skeletal carcinoma (primary lesion in the prostate) from metastatic deposits from other primary sites and also from Paget's disease. Determination of the alkaline and acid phosphatase also may be an aid in differential diagnosis occasionally.

CLINICAL PICTURE

Prostatic carcinoma most frequently starts near the capsule. Cancer degeneration of benign hypertrophic tissue is considered rare or improbable by Moore. The malignant growth is frequently inoperable before it manifests its presence by urinary obstruction, pain or hemorrhage. If a previous prostatic obstruction was present, a malignant change may be well established before the bladder symptoms change. On the other hand, if obstruction was not present, the malignant change may be well established before symptoms of obstruction appear. The effects of cancer, in addition to those inherent in the disease itself, are practically always the result of urinary obstruction and consequent urinary infection. As the malignancy spreads by way of the perineural lymphatics, pain in the legs or back and perineal distress are early symptoms. Bladder obstruction is due to fixation of the prostatic and membranous urethra as well as to actual encroachment by the cancer upon the lumen of the prostatic urethra.

The first metastases usually encountered are in the lower spine, the femur or the pelvic bones. Though it is very rare, I have seen one early metastasis to a tibia. Later metastases may be general. Cachexia or a moderate loss in weight, anemia and fatigue are frequently associated with advanced cancer, with or without bladder obstruction and urinary infection or an elevated blood nonprotein nitrogen and acidosis. These conditions are often improved simply by reducing the degree of urinary obstruction, lessening the absorption from the urinary obstruction and improving kidney function. This may be done by surgery or by castration or the administration of stilbestrol. In the latter instance (castration or stilbestrol) it is necessary, of course, that the obstruction be due to the cancer and not to an early malignant change in a previously obstructing prostate of benign fibrous or adenomatous type.

CHOICE OF TREATMENT

Prostatectomy—Prostatectomy may be the treatment of choice in benign adenomatous hypertrophy with early malignant change. For example, let us consider a case of long standing prostatic hypertrophy as evidenced by nocturia four to six times and a weak stream which in particular is slow to start in the morning when the bladder wall is weakened by overstretch. The patient reports for examination with no suspicion that anything serious is wrong with him, since his bladder symptoms have not changed notably for 2 years. He considers his general health satisfactory. We find 200 cc of uninfected residual urine, a trabeculated bladder and large intracystic lobes. Rectal examination discloses a nodular hypertrophy, undoubtedly benign, except one area which is hard and fixed to the urogenital trigone and prostatic capsule at the lower pole of the right side. The growth has extended to the membranous urethra and therefore, beyond the pros-

tatic capsule. If it has not spread to the membranous urethra we must in such an instance employ Young's radical perineal prostatic operation. When the cancer is confined within the prostatic capsule this operation will effect a cure in 2 to 3 per cent of cases at least for a 5 year period.

In the case under discussion the adenomatous prostate is large, the cancer small, and while obstruction may sometimes be due to fixation of the membranous urethra by the cancerous growth in this particular case it is more likely due to the hypertrophy itself. Perineal or *always a one stage* suprapubic removal of the hypertrophied prostate will relieve the obstruction and undoubtedly permit the establishment of the diagnosis by section and pathologic study of the suspicious area. A two stage operation should never be done in these circumstances since the prostate becomes too firmly fixed after preliminary suprapubic drainage. If the suspicious area is too large, transurethral resection with or without perineal biopsy would be preferable to open surgery. In either instance we expect to remove only a part of the cancer tissue. We operate only to remove the benign obstruction. The cancer should be treated by hormone therapy.

While it is true that prostatectomy is rarely indicated when rectal palpation quite definitely establishes the diagnosis of carcinoma of the prostate, there may be circumstances as in this case which make it advisable. The acid phosphatase in this case was 4 King Armstrong units and the alkaline phosphatase 10 Bodansky units. The x-ray pictures of the pelvis and femurs were negative and the blood nonprotein nitrogen and carbon dioxide volume per cent slightly elevated. Castration is not indicated at this stage. One might favor giving diethylstilbestrol 10 to 15 mg daily by mouth for 3 or 4 weeks and then reconsider the situation before operating. While I have never known a small malignant growth of this kind to disappear entirely, even by rectal palpatory criteria, under stilbestrol therapy it does become smaller in many instances and may remain stationary for months.

After enucleation of such a prostate we fully expect recurrence of the malignant growth but since the adenomatous obstruction has been removed we may now unhindered turn our attention when it becomes necessary to the recurrence. Stilbestrol administration is begun upon the establishment of the diagnosis. Castration may later become necessary. We have given this patient bladder comfort and the work of Huggins has given him hope!

Transurethral Prostatic Resection—Voluntary sphincter action is brought about by the pull of a mobile prostatic urethra (Rose¹) against the membranous urethra. The up and down movement of the prostatic urethra and internal orifice of the bladder is accomplished by the action of the voluntary perineal muscles. To stop urination and to control leakage the internal orifice must be maintained in an elevated position by the tone of the perineal muscles. Fixation of

the prostatic urethra by cancer prevents this normal position and function. Also shrinkage of the prostate due to either castration or stilbestrol therapy following previous transurethral surgery may bring about an occasional delayed urinary incontinence. Transurethral resection will in many instances re establish bladder function satisfactorily.

It is wise not to operate too hastily since incontinence associated with frequency of urination may occur if too much tissue is removed or it may develop some months after the operation and after hormonal therapy has been established. When the prostatic urethra is fixed that is immobile in cancer tissue transurethral surgery may only cone out the internal orifice of the bladder and urine will leak into the prostatic urethra and on out through the fixed voluntary sphincter.

Catheterization—Intermittent or Retention—Catheterization in general is contraindicated since it infects the urethra and urine contracts the bladder and so endangers kidney function because it does not relieve the obstruction. When a catheter is used surgical or hormonal reduction of prostatic obstruction should follow very soon.

Patient M reported with prostatic obstruction. His general health was excellent and the laboratory findings were normal. Rectal examination showed a large rather smooth and unusually round hard fixed prostate. The diagnosis was cancer of the prostate. Symptoms of bladder obstruction while annoying permitted sufficient sleep and allowed the patient to work. Palpation of the abdomen disclosed a bladder overfull extending to the umbilicus. The voided urine was not infected as determined by methylene blue stain of a freshly voided centrifuged specimen. For fear that this patient might be catheterized and so infected before we could reduce the obstruction by hormone therapy he was hospitalized. Diethylstilbestrol 10 mg twice a day was given by hypodermic and 5 mg three times a day after meals was given by mouth for 12 days. At the end of this time the urinary stream was quite free and the bladder immediately after voiding now reached half way to the umbilicus. The patient was discharged from the hospital. He returned for observation 6 weeks later at which time his prostate was small round and hard. There was now very little evidence of urinary obstruction and a residual urine could not be determined by suprapubic palpation or percussion. The patient was never catheterized. He is at this time taking 5 mg of stilbestrol daily and nothing further will be done until it may become necessary.

This case brings out the point that transurethral resection or *catheterization* either intermittent or retention may be omitted with definite benefit in cancer of the prostate. Hormonal therapy will reduce the obstruction and in the circumstances outlined is the treatment of choice.

Hormonal Therapy with Delayed Surgery—The patient an active man in good health with some moderate but well established prostatic obstruction notices an increase in this obstruction and reports to his physician. A definitely malignant prostate is found but there is no residual urine. The patient's general health, bladder function and laboratory findings are satisfactory. In such an instance one should administer stilbestrol and follow the effects of the therapy upon the size

and progress of the cancer growth noting particularly ankle edema painful breasts and tender nipples Ten to 15 mg of diethylstilbestrol (by mouth) a day is a satisfactory initial dose The testes may become soft and possibly one fourth smaller than normal When such a change occurs and if then the breast changes are noticeable but not marked and the prostatic growth enlarges perceptibly it is advisable to castrate the patient No urinary obstruction may occur in certain of these cases

Dosage of Stilbestrol—The side effects of stilbestrol which are enlarging breasts tender nipples and edema of the extremities occur more quickly and with smaller doses in some individuals than in others The hot flashes and nervous discomfort which occur after castration are occasionally relieved by small doses (0.2 to 0.5 mg) of diethylstilbestrol daily but even these doses may produce the undesirable side effects

A patient may take by mouth 15 to 35 mg of diethylstilbestrol daily and exhibit no local or metastatic cancer control and no side effects while another will require only 0.5 mg daily to produce ankle edema breast changes and possibly excellent local cancer control Stilbestrol subcutaneously may be used for a short time to institute the treatment Each case is an individual problem

Castration—What is the clinical value of castration over the administration of stilbestrol? Huggins states that he has never seen a disappearance of bone metastases following administration of stilbestrol alone but that when castration has been done he has seen such metastases heal (by increased density or calcification) and then completely disappear with replacement by normal bone With this statement we agree and therefore we favor castration over stilbestrol when bone metastases are present Certainly in these cases the patient's sense of well being is definitely improved in 80 per cent or more of cases Again the greater amount of cancer tissue to combat very often the less favorable are the results from stilbestrol and the more castration is indicated however the prognosis may be unfavorable with either method in such cases even though the patient's well being strength appetite and the blood picture are often temporarily improved When stilbestrol has little or no effect on the cancer it is probable that castration will not be markedly beneficial nevertheless the operation should be carried out

I distinctly favor giving stilbestrol (by mouth) at first rather than immediate castration in early or doubtful cases In a large percentage of advanced cases castration will usually be the treatment of choice However when bony metastasis cannot be demonstrated stilbestrol may be tried on an empirical basis A favorable response to stilbestrol suggests possibly a more favorable response to castration We have had both successes and failures with each method within the limited period of time since their introduction

X Ray Radium and Radon Seeds—Probably no cancer of the prostate has ever been cured by x ray therapy. However during the years that it constituted one of our chief therapeutic measures we often saw the pain of prostatic cancer relieved by it. We thought that this was due in part at least to its influence on the spread along the perineural lymphatics. During these years we have had patients live 6 8 10 or even 17 years at times possibly due more to the presence of a low grade malignancy than to the effects of the x ray therapy. Why discard such an ally especially when other methods fail to halt the spread of the cancer. When in particular it invades the floor of the bladder or when the bone metastases are painful even after castration and the administration of stilbestrol x ray therapy should be used. X ray therapy to the testes has not proved effectual in the hormonal treatment for prostatic cancer. Perineal implant of radium or radon seeds offers little or no assistance to hormonal and surgical treatment.

SUMMARY

1 Cancer of the prostate insidious in its onset is frequently inoperable before it is diagnosed. Young's radical perineal prostatectomy offers a 2 to 3 per cent chance of 5 year cure in those cases in which a diagnosis is made and operation is done before the growth extends beyond the capsule of the prostate.

2 Suprapubic or perineal partial prostatectomy is occasionally of value when the obstruction is benign and the associated cancer small but inoperable. Such an operation is for relief of the urinary obstruction alone the cancer itself being treated with hormonal therapy.

3 Hormonal therapy consisting of diethylstilbestrol by mouth may in certain cases reduce the size of an obstructing malignant prostate sufficiently so that transurethral resection of the prostate or catheterization will be unnecessary.

4 Transurethral resection of the prostate is the operation of choice in definitely malignant and obstructing prostates. Its performance is attended by urinary incontinence in a small percentage of cases which may occur immediately following the operation or may be delayed due to later further reduction in the size of the obstructing gland by hormonal therapy.

5 Hormonal therapy may be carried out by removal of the testicular hormone (castration) or by its neutralization by the administration of an estrogen. Stilbestrol is the hormone referred to in this report. Each method has its special field. In general stilbestrol is used in early small malignancies and castration after bone metastases have occurred. The dosage of stilbestrol is determined by the resulting general sense of well being the size of the cancer and its spread and control and the decrease in size and consistency of the testes. Undesirable side effects such as tender nipples enlarged breasts and edema of ankles are fur

ther dosage indicators. Failure of stilbestrol to control the malignancy suggests that castration should be done immediately.

6 X ray therapy with or without surgery but with hormone therapy is indicated for radiosensitive growths and when the prostatic cancer spreads to the floor of the bladder and for the relief of pain.

7 Our previous surgical and x ray methods for the control of prostatic cancer have been greatly assisted by the work of Huggins who has given us hormonal therapy. In our efforts to cure prostatic cancer hormonal therapy is by far the most efficient treatment yet found, but we should continue to employ our older methods in association with the new whenever they are individually indicated.

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A CLINIC ON CARCINOMA OF THE PENIS

Based on a Clinical Study of One Hundred Thirty Eight Cases

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GENTLEMEN We have before us in the amphitheater this morning a patient who shows a lesion which I am sure most of you will say is a rare one. We shall discuss in detail the symptoms and signs of which he complains and rationalize that treatment which to us seems indicated.

The patient is a 65 year-old man who has engaged in farming throughout his entire life. He tells us that about 4 years ago he first noticed a burning sensation on urination and that shortly afterward a sore appeared just inside his penile urethra. With a rather amazing degree of stolidity and fortitude he has watched a small sore on the tip of his penis develop over the years into a rather sizeable lesion. His past and family history is somewhat significant. His father died of carcinoma of the face, his mother of carcinoma of the stomach and a brother died of a cancer whose site and origin are unknown to him. In addition he tells us that he had a gonorrheal infection from which he completely recovered many years ago.

The patient is a hardy, robust, well-nourished individual who to casual inspection appears to be in perfect health. General physical examination, neurological examination and the flocculation test for syphilis are all negative.

Directing our attention to the genital area, it is to be noted that there is a rather large cauliflower-like, reddened, fungating, raised ulcerative tumor mass that has involved and, in fact, has practically destroyed the entire glans penis. The freshly made wound on the left lateral surface of the tumor mass, involving as you see a goodly portion of normal tissue, resulted from a biopsy of this lesion several days ago. A microscopic section of which shows it to be unquestionably a squamous carcinoma of but a moderate degree of malignancy. You can, of course, see that the shaft of the penis is relatively normal and intact, and that the growth has not encroached upon it. Neither inguinal area shows any evidence of lymphadenopathy and this is encouraging from a prognostic viewpoint, as we shall see a little later when we come to a consideration of the anatomy of the penis together with its lymph drainage.

Now that we have definitely established the diagnosis of cancer of the penis, we must decide upon a course of treatment which will net this man a comfortable and lasting result. Three methods are open to us. The first consists of surgery alone, the second of radiation, and the third is a combination of both surgery and radiation. Which method can we best apply to this patient? It seems to us that a careful summary of findings and results in 138 cases which have been seen

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at the Barnard Free Skin and Cancer Hospital between the years of 1906 and 1944 might be of value in arriving at a decision.

INCIDENCE AND ETIOLOGY

Frequency—Carcinoma of the penis has ceased to exist solely as a pathologic curiosity and has come to occupy the position of a well defined clinical entity which merits careful consideration. Various¹ it has been estimated to comprise from 1 to 3 per cent of all cancer in the male and in certain areas the incidence is much higher. N² states that the average frequency of penile cancer in China is 18.3 per cent in the other Far Eastern countries 18.9 per cent and in Continen



Fig. 435—Destructive ulceration of carcinoma of glans penis.

tal Europe 4.9 per cent. Wolbarst³ in the United States reported penile carcinoma as representing 2 per cent of all carcinomas in the male and Andrews⁴ in Great Britain found it to constitute but 1.27 per cent of 7881 cases of primary cancer. One cannot readily explain the difference in incidence in various parts of the world.

Etiology—The etiology of carcinoma of the penis as of all carcinoma remains obscure. The prepuce or the glans penis is the most common site of origin. Only rarely does it begin in the mucous membrane of the urethra. Barney¹ observed the presence of phimosis in 83 per cent of his cases and Jorstad⁵ reported its presence in from 20 to 40 per cent in his series. The rarity of penile carcinoma among Jews seems noteworthy. Wolbarst³ in a most meticulous study of the rela

tion between circumcision and penile cancer could find not a single instance of carcinoma of the penis in a circumcised Jew. He did however find a cancer of the penis in an uncircumcised Jew. His conclusion is that the apparent Semitic immunity is not inherently racial but results from ritual circumcision. He postulates that circumcision in infancy would eliminate the disease—a conclusion deserving weighty consideration in cancer prevention. Dean⁶ on the other hand does report an instance of carcinoma of the penis in a Jew who was circumcised in infancy.

At times in our series of cases syphilis seemed to be of possible etiologic significance. Several of our patients developed a carcinoma at the site of a previous chancre. Gonorrheal infection was noted not infrequently. The accurate evaluation of venereal infection as a predisposing or causative factor in the production of the cancer is difficult.

Age Incidence.—The age at which carcinoma of the penis develops corresponds with its development in carcinoma of other organs. Creite reports a carcinoma of the penis in a boy of 2 years. Frever⁸ in a boy of 15 years. Ralph⁹ in a young man of 22 years and Fillewicz,¹⁰ in a man of 76 years. The disease is most commonly found in the fifth and sixth decades of life. The youngest patient in our series was 30 years old; the oldest was 88 years. Eight patients were in the fourth decade, 21 in the fifth, 45 in the sixth, 34 in the seventh, and 28 in the eighth decade, and two were octogenarians.

PATHOLOGY

In the vast majority of instances penile cancer begins on the glans penis or prepuce; rarely in the urethra. In most individuals the growth spreads to involve both the glans and prepuce before the patient presents himself for treatment.

Microscopically penile cancer begins as a warty excrescence which proliferates rapidly, forming a cauliflower mass that may in time involve the whole organ. Extensive ulceration may occur and the whole penis is occasionally destroyed. Not infrequently the tumor persists for many years without causing excessive discomfort. Generally speaking the growth tends to remain superficial. Although extension through the tough fibrous corpora cavernosa is uncommon, yet this can and occasionally does, occur.

Lymph Drainage of Penis.—Kuttner¹¹ demonstrated that the superficial penile lymphatics drain to the inguinal glands, while the deep lymphatics empty into the pelvic nodes following the course of the blood vessels or the organ. Nicoll¹ says: "The lymphatics of the anterior half of the penis pass almost wholly to the dorsum; the main channels passing back on either side of the dorsal vein to the oblique set of superficial glands of the groin; in the first instance secondarily thence to the deep inguinal glands lying along the external iliac vessels on the brim of the pelvis. Few, if any, of the lymphatics of the anterior

half of the penis pass to the deep lymphatic channels of the root of the penis which channels pass under the pubic arch to the intrapelvic glands. Cunningham¹³ and Gray¹⁴ on the other hand state that the lymphatics from the glans penis which is the expanded portion of the corpus spongiosum and the urethra may pass directly to the external iliac chain either over or under the symphysis pubis.

Course of the Disease—If as frequently happens the disease involves the inguinal glands early it tends to become limited to these glands, which possibly accounts for the fact that the disease process may extend over a period of several years or longer. Though recurrence takes place the progress is slow and visceral metastases are infrequent. Death is usually due to cachexia or to ulceration and erosion of the blood vessels with hemorrhage.

DIAGNOSIS

The diagnosis is as a rule easy, the warty excrescence or ulcerative type of lesion being in evidence (Fig. 435). However papilloma, epithelioma like chancre and noncancerous ulcers due to personal uncleanliness must be differentiated. Generous biopsy to include a goodly margin of healthy tissue in addition to tumor tissue may be the only positive method of identification.

TREATMENT

In perusing the literature one is impressed with the unanimity concerning the occurrence, etiology, age incidence, pathology and diagnosis of penile carcinoma. On the other hand there is by no means complete accord as to treatment. It is our increasing feeling that the successful eradication of the disease is directly dependent upon and proportionate to the extent and degree of radical surgery. Dean¹⁵ in discussing Jorstad's paper in 1941 said: "If a tumor is superficial and no larger than 2.5 cm. in diameter ideal treatment can be given with low voltage roentgen rays. Since penile cancers are malignant squamous cell growths and are radioresistant it would seem that the size of a lesion may not be of too great value in determining the indication for or the efficacy of radiation. These tumors are inherently unresponsive to radiation."

Dean¹⁵ further contends that since carcinoma of the penis spreads through the lymphatics by tumor embolism it is sufficient to amputate but 1 cm. proximal to any visible or palpable disease and states that he has had no recurrence in the amputation stump of over 200 cases thus treated. No one though urges the parallelism of simple mastectomy for breast cancer. If recurrence followed this procedure the conservatism would be derogated and local or distant recurrence would be assumed to have been the result of inadequate surgery. We see no dissimilarity in the mere local extirpation of penile and breast malignant growths. Who of us would be so heretical as to advocate

simple mastectomy in breast cancer² No one will deny the necessity of wide excision of the cancerous breast and its associated lymph glands if arrest of the disease and the preservation of the life of the individual is to be accomplished It would seem to us illogical from a cosmetic functional therapeutic and sexual and genital point of view to attempt to preserve by surgical homeopathy a penis invaded by cancer

Barney and Barringer¹⁶ stress the protective value of the preserved regional lymphatics and therefore do not advocate their removal These authors propose aspiration biopsies to determine inguinal gland involvement but this would seem to necessitate the presence of an inguinal node large enough to aspirate and everyone knows how frequently lymph glands too small for accurate clinical identification can be present and contain multiple malignant metastatic cells As Jorstad¹⁵ said when a metastatic squamous cancer cell has migrated to a lymph node that node ceases to be of protective value and can at any time flare into a mass of unregulated cancer cells

It seems noteworthy that in a previous report by one of us (W E L) *all the 19 living patients from the group of 43* who were treated had had bilateral inguinal adenectomy In our series of 138 cases 43 patients refused treatment or for one reason or another did not receive treatment It seems regrettable that 31.6 per cent of our patients should have failed to avail themselves of the opportunity of cure or palliation (Figs 436 and 437)

Choice of Procedure—Radium and Roentgen Therapy—Ten patients received radium or x ray therapy One of these received both radium and x ray the remaining 9 radium alone Two of these 10 patients had no follow up or were unreported Six died of recurrence One was living at the end of 2 years and one at the end of 3 years Thus it is seen that 60 per cent of the radium roentgen cases were failures

Partial Amputation of the Penis Alone—Only 4 patients were submitted to partial amputation of the penis as the sole treatment There were no postoperative deaths One patient was unreported one died 1 year later of carcinoma of the face (No recurrence of penile carcinoma was then noted) One was living at the end of 7 years one at the end of 5 years and one at the end of 6 months Obviously no pertinent conclusion can be drawn from so small a number in which partial amputation only was done

Partial Amputation with Inguinal Adenectomy—Ten patients were treated by partial amputation with inguinal adenectomy There were no postoperative deaths in this group either Three cases were unreported One patient died of recurrence at the end of 1 year another 2 years later of heart trouble and one was alive 12 years later three were alive 6 years and one 5 years later Two of these patients had had radium applied to their lesions with recurrence and subsequently partial amputation and inguinal gland dissection One survived 12

months and another 6 years. The average survival period was 4 years in this group.

In 50 per cent of those patients submitted to bilateral inguinal adenectomy and partial amputation the lymph nodes contained metastatic squamous cancer cells at the time of operation. The average survival period of those whose glands contained metastases was 3.5 years and when no cancer was encountered in the nodes the average survival period was longer 4.5 years.

Total Amputation and Bilateral Inguinofemoral Gland Dissection—Thirty-one patients were treated by total amputation and bilateral inguinofemoral gland dissection. As a general rule total phallectomy and inguinal gland dissection were carried out in one stage. There were 2 postoperative deaths, an operative mortality of 6.6 per cent. All patients were followed. Nine patients died of causes other than cancer and were not known to have had a recurrence of their penile carcinoma at the time of their death. They lived 18, 9, 7, 6, 5, 2, 2, 1, 1 years respectively. Nineteen patients are alive and well—one 16 years, one 10 years, two 7 years, one 6 years, three 5 years, two 4 years, two 3 years, one 1 year, 6 living some months. The average number of years survived by each patient was 5.8. Only one patient died of a recurrence.

In this group no mention was made of the microscopic appearance of the lymph nodes in 6 cases. Of the remaining 25 cases where the nodes were carefully assayed 52 per cent were found to contain metastases and 48 per cent were not yet invaded by the growth. The average survival period in those patients whose records detailed the microscopic lymph node appearance was 3.6 years in those whose glands contained metastases and 4.4 years where no nodal cancer was found.

Total Emasculation—This procedure was done on 20 patients. There were 5 postoperative deaths, a mortality of 25 per cent. Two patients died of recurrence. Two were unreported and two died of causes other than cancer, one 17 years and one 6 years later. Nine patients were alive 30, 12, 11, 10, 10, 6, 6, 4, 4 years respectively. Each patient lived an average number of 9.33 years. In eight instances (mostly in the very early records) no comment concerning the presence or absence of nodal involvement was available. In 50 per cent of the cases metastases had occurred at the time of operation. Where glandular involvement had not taken place the average survival period was 7.2 years, whereas in those having metastases it was 6.6 years.

Total Amputation and Bilateral Inguinofemoral Adenectomy—Anatomical Considerations—A precise appreciation of the anatomy involved is of course essential to the proper execution of this surgical procedure. The lymphatics of the penis and scrotum drain into the superficial lymph glands in the superficial fascia beneath the inguinal ligament in the femoral triangle. The superior group is parallel to the lig-

ment while those of the inferior group are arranged vertically on either side of a line perpendicular to the center of the fossa ovalis. The superficial glands anastomose through the cribriform fascia with the deep subinguinal or deep femoral glands two or three in number which lie beneath the fascia lata. The upper one known also as the gland of Cloquet or Rosenmuller is in the femoral canal and often projects into the pelvis where it is in communication with the glands of the external iliac chain. The deep inguinal glands may receive vessels directly from the glans penis and in turn send efferents to the external iliac tract. The lymphatics of the urethra empty some in the deep group of inguinal glands and others pass over the symphysis between the recti muscles to terminate directly in the iliac chain.



Fig 436—End result after penile amputation and inguinal dissection

Technic—After administration of a spinal anesthetic consisting of 100 mg of procaine hydrochloride supplemented by 10 mg of pontocaine we shall have sufficient anesthetic effect to complete total amputation of the penis and bilateral inguinal adenectomy. We shall now proceed to cover the cancerous mass on the penis. (A rubber dam may be used for this.) A curved incision is made from one anterior superior iliac spine to the other along the fold of the groin across the pubis to meet a similar incision on the opposite side. The skin flap is reflected upward. The fat and fascia down to the external oblique aponeurosis are dissected downward to the region of the inguinal ligament. The base of the penis is encircled. The lower skin flap over the

femoral triangle is then reflected downward and outward to expose its contents. Beginning laterally, the fat and fascia with the enclosed lymphatic glands are dissected from the deep fascia toward the medial side of the thigh. The deep femoral glands may form a mass continuous with the superficial glands and should be removed at the same time. It may be necessary to divide the fascia lata and even the inguinal ligament in order to reach the gland of Cloquet but more often it is easily removed from the femoral canal without division of the ligament. Several vessels namely the superficial epiaortic superficial circumflex iliac and superficial external pudendal will require ligation and division.



FIG. 437—Perineal implantation of the penis.

After the inguinal dissection the scrotal contents are easily separated from the crura of the penis. The corpus spongiosum is separated from the body of the penis and divided anterior to the bulb at the proper length for insertion into the perineum. A sound is then placed in the bladder to facilitate further freeing of the urethra. The suspensory ligament is then divided and the dorsal vessels are clamped. The crura are separated from the rami of the ischium with periosteal elevator and each crus is clamped with a forceps. The entire penis with attached fat, fascia and lymph glands is then removed in toto. All vessels are ligated and the crura transfixed with catgut. The urethra, obliquely cut, is inserted into the perineum through a stab wound and at

the scrotoperineal angle. It is then sutured to the skin margins with interrupted fine silk sutures. A self retaining catheter is inserted into the bladder and the inguinal skin flaps closed. Because of the usual abundant serosanguineous exudate drainage is instituted. A large dressing is employed to compress the skin over the groin and to eliminate dead space. Spinal anesthesia is being employed by us with increasing frequency in this procedure.

Needless to say meticulous attention to postoperative details is necessary including adequate fluid intake, constant supervision of catheter drainage and the maintenance of continuous pressure to the widely undercut and mobilized skin flaps so that their viability is enhanced. We have not in our experience met with serious objection from our patients in the loss of the penis—contrarily most of them have seemed happy to be rid of a diseased and sloughing organ whose essential usefulness had been largely destroyed. Particularly they did not object to its sacrifice when as a rule many years of life could be reasonably assured them.

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FIBROSARCOMA OF THE EXTREMITIES

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This report constitutes a survey of the fibrosarcomas of the extremities (excluding those limited to the skin) which have been seen at The Barnard Free Skin and Cancer Hospital during the 30-year period from 1915 to 1944. Fibrosarcomas constitute a relatively small group of malignant neoplasms when compared to those of epithelial origin. They are however important because of their marked tendency to recur locally and eventually to initiate distant metastases with fatal termination.

Anderson defines fibrosarcoma as a malignant tumor tending to differentiate in the direction of fibrous connective tissue. Stout calls attention to the confusion which has existed in the literature because of the tendency in the past to refer to these tumors according to their cell structure or according to some gross feature such as vascularity, the formation of mucin or the arrangement of the cells with relation to the blood vessel. He states that where no attempt has been made to determine the type of cell from which a given tumor originates it has not been possible to determine the degree of malignancy or the radio-sensitivity. This certainly has been true in the mesoblastic tumors. Stout agrees with Ludlow that it is possible by the use of differential stains to classify mesoblastic tumors into two groups: those derived from fibroblasts and those derived from hemopoietic, lymphatic or reticulo-endothelial cells. Tving is of the opinion that the majority of fibrosarcomas are neurogenic in origin and arise from peripheral nerve fibers. Warren and Sommer recognize neurogenic fibrosarcoma as a definite subtype. Bick states that histologic variance such as fibromyxosarcoma, angiofibrosarcoma and neurofibrosarcoma present no difference in clinical development, subsequent course or response to treatment.

DISTRIBUTION AND INCIDENCE

Fibrosarcomas are most commonly found in the skin, subcutaneous tissue and intermuscular connective tissue. The extremities are the most common sites for the location of these tumors. In one series of Meyerding, Broders and Hargrave, the lower extremity accounted for two thirds of all tumors. They suggest that the larger volume of the thigh and leg when compared to the upper extremity may account for this difference of distribution. In our series, 16 cases were upper and 24 cases were lower extremity in distribution (Fig. 441 A). Other sites

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have been reported in which fibrosarcomas occur. In fact isolated reports cover almost all organs and tissues of the body.

A survey of the pathological specimens at The Barnard Free Skin and Cancer Hospital from January 1 1915 to January 1 1944 reveals 40 cases of fibrosarcoma of the deeper structures of the extremities. We have purposely excluded all tumors which grossly seem to originate in the skin because malignant tumors of the skin are to be covered elsewhere in this volume. We have observed instances of fibrosarcomas in the breast uterus jaw scalp and neck but have not included them in this report. Twenty four of our cases were in the male and sixteen in the female. Meyerding Broders and Hargrave report a predominance of males in the ratio of 2 to 1. Stout declares there is no real variation in either sex or age since they are found in all ages and equally in either sex. Our age group ranges from 10 to 80 years with an average of $38\frac{3}{10}$ years. The greatest number however appeared in the fourth fifth and sixth decades of life. Warren and Sommer state that the disease is definitely not one of youth and the average age noted in their series is about 50.

PATHOLOGY

Microscopic—Thirty nine of our 40 specimens have been reexamined and the diagnoses confirmed. One patient in whom the diagnosis was confirmed by us was not treated by us but referred back to his phys-

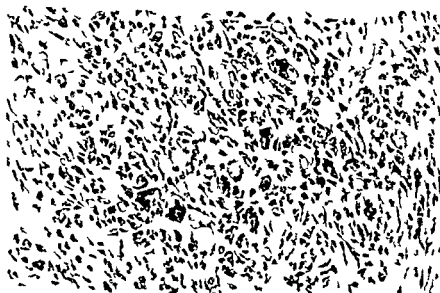


Fig 438—Fibrosarcoma with giant cells ($\times 140$)

ician. This was a case nevertheless in which the diagnosis of fibrosarcoma was definitely confirmed.

We agree with Warren and Sommer that the classification of fibrosarcoma is difficult and as yet unreliable. They state that the presence

and relative number of tumor giant cells is of prognostic significance. We have reexamined our specimens with particular reference to the pres-

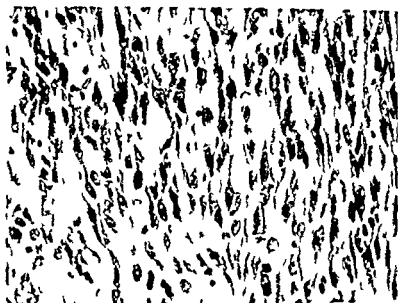


Fig. 439—Spindle cell sarcoma ($\times 40$)



Fig. 440—Fibromyxosarcoma ($\times 60$)

ence and relative number of tumor giant cells (Fig. 438). In the 7 patients who have remained alive and well for 5 or more years 4 show no tumor giant cells, 2 reveal a few, and 1 shows a moderate number

There are 13 patients known to be dead of the disease. Two show a few tumor giant cells, 3 show numerous tumor giant cells, and 8 reveal none. The group which we have been unable to follow adequately contains 7 patients alive and free from disease from 21 to 38 months after treatment. Three of these cases contain many tumor giant cells, 1 contained a few, and 2 contained none. It appears to us that in our limited series of 35 treated cases the presence or absence of tumor giant cells is an indifferent matter prognostically. All our tumors were strictly in the fibrosarcoma group as illustrated by Figure 439, with the exception of 4 cases which showed a definite myxomatous admixture (Fig. 440).

Gross—Fibrosarcoma of the extremities possesses no characteristic gross appearance. The tumor may be firm or soft, depending upon its structure, and either large or small, depending upon the duration and the rate of growth. Ulceration may or may not be present. The tumor frequently seems to possess a capsule, although it has been shown that this is not a true capsule. The cut section of a tumor grossly may be firm or hard. From our experience we are of the opinion that one should lean toward the diagnosis of fibrosarcoma in a tumor of the extremity which has been subjected to local excision with recurrence within a year.

DURATION BEFORE TREATMENT

The duration of the tumor before treatment was instituted seems to us to be rather significant. In 6 of the 7 of our patients who have remained alive and well for 5 years and more, the average duration of the tumor was 10½ years before treatment was begun; in one case the duration of the disease was not stated. In the patients known to be dead of the disease, the average duration of the tumor before treatment was 3 years. In 3 instances in this latter group the duration was given as 9, 10, and 14 years, respectively, and in the remaining 10 the duration of the disease was 1 year or less. It would therefore seem from our limited series that those patients who present themselves for treatment with a history of long duration seem to have a better chance of survival than those in whom the duration of the disease is short. This factor, however, is stated by Warren and Sommer to play no role in the ultimate outcome of the disease.

TRAUMA AS A CAUSATIVE FACTOR

The general impression prevails that sarcoma not infrequently follows trauma, and that it may occasionally follow a single injury. Stout presents a case of fibrosarcoma which developed on the sole of the foot of a woman who bruised her foot on a stone while wearing very thin shoes. Two months later she noticed a tumor at the site of the bruise. The tumor was excised several times with prompt recurrence, but the patient remained well after amputation. Stout also cites

several cases collected from the literature in which fibrosarcoma followed a single injury. Meyerding, Broders and Hargrave report a history of preceding trauma in 32.9 per cent of their cases and state that in 11 per cent they were of the opinion that there was a definite relationship between the trauma and the tumor. Warren and Sommer however deny that trauma is a factor.

In our series there were two instances which seem definitely to have followed injury, an incidence of 5 per cent. One patient, a 29 year old male farmer, presented himself with a tumor on the lateral aspect of the left forearm which appeared as a lump immediately following a bruise. The lump persisted and was treated with radium elsewhere with no regression. Within a year a wide local excision was performed and there were 4 recurrences of the tumor in the next 3 years. Another patient, a 17 year old schoolboy, gave a history of a severe bruise on the leg 4 months before hospital admission. He stated that the tumor appeared following the bruise and had persisted until the time of entrance. The thigh was amputated and he died 10 months later with generalized metastases.

LOCAL RECURRENCE AND DISTANT METASTASES

Local recurrence seems to be rather characteristic of fibrosarcoma unless a very wide excision or amputation is employed in the treatment of the original tumor. Taylor and Nathanson report 256 cases, 159 of these represent recurrence after one or more excisions and of the remaining 97 primary cases, some recurred after one or more attempts at a cure. It is stated by Warren and Sommer that recurrence of the tumor offers a grave prognostic significance. In a series of cases reported by Burt, recurrence is stated to be common. Bick states that amputation is imperative at the first sign of recurrence.

Twenty cases or 50 per cent of the tumors included in our series were recurrent when the patients applied for treatment. Thirteen of our 40 patients are known to have died of the disease from distant metastases and one is known to have had multiple recurrences. There are several instances in our series which seem to bear out the contention of Bick, namely, that amputation is imperative after the first sign of recurrence. One patient with fibrosarcoma of the arm was operated upon on September 23, 1919, and the tumor recurred in 1 year. On September 15, 1920, an attempt was again made to remove the tumor unsuccessfully. Amputation was advised but refused. During the next 4 years radium therapy was instituted without success. In January, 1925, the arm was amputated at the middle third. Since then there has been no recurrence of the tumor and 14 years later, when last observed, the patient was alive and well. The other patient is a young farmer, 29 years old, whose tumor appeared on the left forearm following a bruise. He was treated with radium before applying at our clinic. A local excision was done but the tumor promptly recurred.

Subsequent to our first treatment there were 4 recurrences each following local excision. Three years after the first treatment the arm was amputated. There has been no information from this patient since the amputation.

METASTASES TO THE REGIONAL NODES

Usually sarcoma is thought to metastasize directly through the blood stream but a sufficient number of metastases to the regional glands have been reported to make us aware of its importance. Nathan

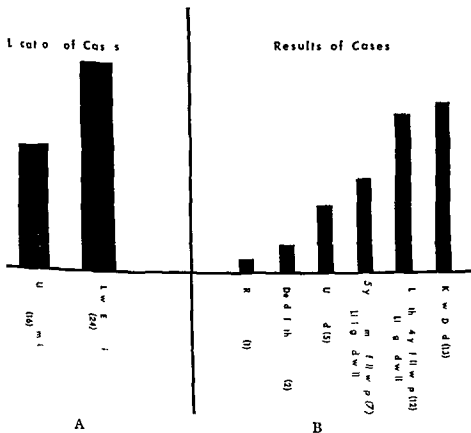


Fig 441—Location and results in 40 cases of fibrosarcoma of the extremities

son and Taylor report an incidence of known lymph node metastases of from 5 to 8 per cent. They state that the number of instances of involvement does not warrant the recommendation of routine regional dissection in all cases of fibrosarcoma. Meyerding, Broders and Hargrave found 5 instances of regional metastases in 152 cases. Burke reports 15 metastases in 201 cases. We have noted 5 instances of lymph node metastases in 40 cases. One of these patients is dead. The remaining 4 were alive and well when last observed: 3 months, 22 months, 28 months, and 29 months after operation. As a result of the rather high incidence of regional metastases, we are of the opinion that a routine

dissection of the regional glands should be performed. Generalized metastases accounted for the death in most of our 13 cases which have terminated fatally.

TREATMENT

The treatment used in this series of cases was *surgical* except when the patient refused operation or the lesion was inoperable. A wide local excision should be done if possible. The extent of the tissue removed as noted by Bick cannot be measured but remains a matter of surgical judgment. Should excision not be feasible or result in loss of function amputation must be resorted to. Early in our experience *radium therapy* was used in one instance of a fibrosarcoma of the fore arm but did not prove effective. 19 800 mg. hours of radium were applied over a period of 5 years. In spite of this intensive dosage of radiation the tumor persisted and recurred and when amputation was performed tumor tissue was demonstrable in the specimen.

There seems in our group of cases to be no correlation in the type of operation used and the end result except to state that recurrence developed promptly when a limited excision was performed. The problem of treatment in this group of tumors is the same as in any other group of malignant tumors that is the disease must be eradicated before distant metastases have occurred. Therefore it is extremely urgent that all of the tumor be removed at the first operation. In the group of 7 known 5 year survivals 3 patients received wide local excision 2 amputation and 2 received disarticulation. The results of treatment in our 40 cases is set down in the Fig. 441 B.

SUMMARY

1 Thirty five cases of fibrosarcoma which have been treated at the Barnard Hospital are reported.

2 In 7 (20 per cent) of these 35 cases the patients have survived or more years.

3 Six additional patients have been followed and are alive and well for 21 24 26 31 36 and 38 months postoperatively.

4 Thirteen are known to be dead of the disease.

5 Two have died from other causes in less than 5 years.

6 One is known to have had a recurrence after 3 years.

7 Radiation as we have used it has been ineffective.

8 Tumors of long duration before treatment seem to offer a better prognosis than do those of short duration before treatment.

9 The average duration of life after treatment in 13 fatal cases was 8 7 months.

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MALIGNANT LYMPHOMAS OF THE SPINAL EPIDURAL SPACE

D J VERDA MD FACS

The subject of this clinic is a group of malignant tumors genetically related occurring in the spinal epidural space which arbitrarily have been grouped with all malignant lymphadenopathies under the genetic heading malignant lymphomas. This term was first suggested by A von Winiwarter in 1875 and has been used since by Henry Jackson Jr (1937) and by Gall and Mallory (1942) and it seems to fit present purposes better than any other suggested nomenclature. In the first place there can be no question of the malignancy of these tumors their blastomatous nature having been established beyond doubt. Clinically and pathologically they are endowed with all the basic attributes of malignancy they progress until death occurs usually rapidly though occasionally very slowly. Finally since they primarily involve lymphoid tissue they are true lymphomas.

Varieties of multiple malignant lymphomatous growths found in the spinal epidural space include Hodgkin's disease (classical form) lymphosarcoma reticulum cell sarcoma plasmoma giant follicular lymphoma myeloma (solitary and multiple) various forms of leukemia chloroma and mycosis fungoides. Other varieties of malignant lymphomas such as leukosarcomatosis lymphocytoma monocytoma and eosinophiloma belong to this generic group but because of the paucity of the available data on them they are mentioned merely for the sake of completeness.

Ewing describes three elements in lymphoid tissues that may give rise to such lymphomas viz (1) lymphocytes (2) reticulum cells of follicles and pulp and (3) endothelial cells of pulp and cavernous sinuses. Lymphomas do not necessarily arise from elements within lymph nodes a collection or nest of such elements as demonstrated by Kubie (1927) showed the presence of lymphocytes in nests in the crotch of bifurcated venules or arterioles in the epidural space of the spinal cord. These may act as a locus for the development of extradural lymphoid growths or lymphomas. Some of these lymphomas of the epidural space of the spinal cord commence in that locality as the primary region of involvement and are first manifested by symptoms referable to the spinal cord which dominate the clinical course of the disease. There may be a sudden paraplegia or the patient may experience the gradual onset of a spastic paraplegia first evidenced by

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radicular pains paresthesias urinary disturbances rectal symptoms or girdle sensations This type occurs with sufficient frequency to merit careful consideration in differential diagnosis

Hodgkin's disease of the central nervous system especially when the epidural space is involved may show no clinical evidence to identify it other than the paraplegia Even when the neurological symptoms of Hodgkin's disease are first discerned the diagnosis is frequently delayed for many years Why should there be such long delay in diagnosis? Ginsburg (1927) in a series of carefully studied cases revealed that most clinicians and diagnosticians still hold to the original conception that Hodgkin's disease must always start with enlarged cervical nodes and the prevalence of this idea even today is most likely responsible for many failures to recognize the disease in its early phases

ANATOMY OF THE SPINAL EPIDURAL SPACE

The spinal epidural (extradural) space refers to the space separating the outermost meninx (dura mater) from constituents of the vertebral column The volume of the space is insignificant at birth but through unequal expansion of the vertebral canal over the meninges and contents it may attain a depth of 0.4 to 0.6 cm in the lumbar region of an adult It extends from the second cervical vertebra to the lower portion of the sacrum The epidural space appears little altered by the cord enlargements these changes in contour occurring primarily at a sacrifice of subarachnoidal volume It is apparent then that epidural tumors in the posterior lumbar region might attain considerable size before cord compression is clinically discernible Conversely a small growth in the epidural space over the cervical enlargement would bear directly on intramedullary tissue

In issuing from the dural space each spinal nerve derives a dural sheath which is prolonged into the intervertebral canal where there is a loose attachment to the periosteum This relationship obtains as well in those nerves entering the sacral foramina With the termination of the dura at the level of the second sacral piece the bulk of dural reflections appears exaggerated over the lower sacral nerves the coccygeal nerve and the filum terminale

The remaining volume of the spinal epidural space is filled with areolar tissue and fat in the substance of which courses the internal vertebral venous plexus (Fig 442) This plexus comprises bilateral longitudinal channels (retia posteriorly and sinuses anteriorly) and their transverse interconnections (posterior lateral and anterior) The radicular veins draining the spinal cord empty into this plexus near the intervertebral foramina In addition the main venous drainage of the cancellous vertebral body is into this plexus

Certain further observations concerning the vascular supply of the region are pertinent to the problem at hand Kady (1880) demon

strated that only a fourth of man's nerve roots is accompanied by segmental arteries. More recently studies by Suh and Alexander (1939)

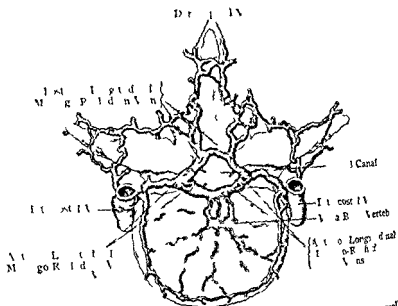
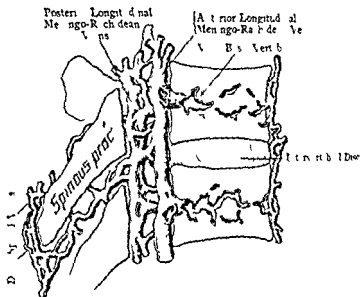


Fig. 447—Internal vertebral venous plexus in spinal epidural space as well as drainage of cancellous vertebral body into this plexus. (From Deavers' *Surgical Anatomy*, courtesy of the Blackiston Co.)

reveal that the blood supply of the spinal cord is dependent on 6 to 8 anterior radicular arteries and from 5 to 8 posterior radicular arteries. In addition they indicate that the drainage of the spinal cord is

pendent on from 6 to 11 anterior radicular veins and from 5 to 10 posterior radicular veins. The radicular veins are distributed in asymmetric arrangement and ordinarily do not leave the spinal cord over the same roots conveying the radicular arteries. This asymmetry accentuates the high degree of regional independence of the arterial and venous circulations in the spinal cord. According to Suh and Alexander the lumbar radicular vessels are an important source of blood supply for the major part of the spinal cord and the middle thoracic section of the spinal cord has the poorest local segmental circulation. These anatomical observations are important for they help to make clear the significance of location of extradural tumors. A small extradural growth arising in the vicinity of a radicular vessel may rapidly cause a myelomalacia involving a large segment of the cord whereas larger tumors in another location remote from any radicular vessel may produce changes only when there is an actual compression of the cord.

MODES OF INVOLVEMENT OF THE SPINAL EPIDURAL SPACE BY THE LYMPHOMAS

It is necessary to ascertain whether malignant lymphomas arise in the epidural space itself or whether they reach that space secondarily having migrated there from nearby regional lymph nodal involvement. The primary region of involvement by the lymphomatous growth may be remote from the point where it was first perceived a phenomenon especially true of tumors of the spinal epidural space. On the other hand there have been some spinal epidural lymphomas that were as far as could be determined unassociated with other involvement of the retroperitoneal mediastinal or lumbar group of lymph nodes. There is substantial evidence showing that such lymphomatous growths arise from multiple foci of lymphoid elements origin it would therefore seem more proper to refer to a primary region of involvement than to a primary source of growth.

In the type case which is described below the spinal epidural space is the primary region of involvement and the clinical course of the patient is dominated by the neurologic symptoms. Initially such patients do not exhibit any clinical evidence of lymphadenopathy other than a localized lymphomatous growth in the spinal epidural space. Considerable surgical aid is possible and the prognosis is moderately good.

CASE I.—The patient O F E, a 31 year old white man, was admitted to the Barnard Free Skin and Cancer Hospital complaining of marked leg weakness and inability to walk. Two months previously his legs began giving way under him and he was becoming weaker every day. He was unable to walk without assistance. His leg weakness increased rapidly until he was unable to stand alone. About this time he noticed an unusual numbness about the anus of such extent that he was unable to discern bowel movements. There was also difficulty with urination.

During the past month he had experienced severe pain radiating down the ball of the left thigh and also extending down the right thigh to the knee level.

Neurological examination revealed marked weakness of both legs with inability to walk unassisted. There was an absence of the superficial leg and foot reflexes and anesthesia involving the lateral and medial portion of the right leg just below the knee level. Anesthesia was definitely circumferential about the anus and most pronounced on the right (see Fig. 443 for neurologic findings). The cremasteric and abdominal reflexes were normal. A Queckenstedt test revealed a complete block, the spinal fluid was markedly xanthochromic and the total protein was 900 mg. per 100 cc.

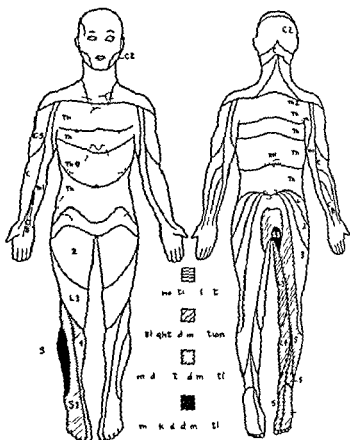


Fig. 443 (Case O.F.C.)—Neurologic findings depicting sensory changes on first admission to Barnard Free Skin and Cancer Hospital.

Röntgenographic Studies—There was absent any definite bony destruction involving either the thoracic or lumbar vertebrae or the pelvis (Fig. 444). The ribs and cervical vertebrae gave no evidence of destruction. Lipiodol studies revealed a complete block between the 2nd and 3rd lumbar vertebrae as demonstrated in Figure 445.

Operation—On January 9, 1941, a laminectomy was done over the spinous processes of the 1st, 2nd, 3rd, 4th, and 5th lumbar and the 1st sacral vertebra. An elongated soft reddish purple epidural tumor measuring 6 by 1 by 1 cm. was found lying on the dorsal lateral surface primarily on the right (Figs. 446 and 447). It was easily peeled off the dura but was attached by a small pedicle.



Fig 444—Anteroposterior view of lumbar vertebrae revealing a lack of bony destruction about the level of the spinal epidural space lymphoma between L and S 1



Fig 445—Roentgenogram of lumbar vertebral region showing complete block to lipiodol at L 2 and L 3

as shown in Fig 447 to a nerve root. The epidural tumor extended from the lower portion of the 2nd lumbar to the 1st sacral vertebra. The postoperative course was uneventful. Three weeks following laminectomy the patient noted marked improvement in leg power and was able to walk alone. He gained weight steadily. Several months following operation he returned to work in an office and clerk (see Figs 448 and 449).

Pathology—There was no evidence of vertebral involvement. Microscopically the tumor was made up predominantly of plasma cells and lymphocytes. The tumor was a noncellular proliferation of plasma cells.

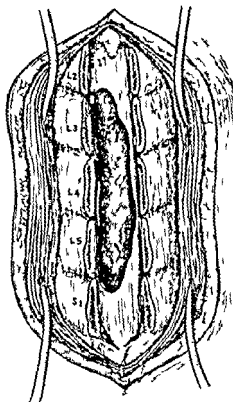


Fig 446



Fig 447

Fig 446—View of spinal epidural space lymphoma found at operation between L2 and S1 measuring 6.0 by 1.0 by 10 cm.

Fig 447—Spinal epidural space lymphoma easily peeled off of the dura. The pedicle attachment is easily seen.

Röntgenotherapy—Several weeks following the healing of the laminectomy wound the patient was given a course of deep x-ray therapy to the site of the spinal epidural tumor using the following factors: 00 kVp, 18 ma, FSD 50 cm, hvl 2.25 mm, Cu oblique ports 15 by 15 cm, Thoracuss I filter 1000 r per port.

In the second group of cases the spinal epidural space is secondarily involved from some distant or regional source as from mediastinal or retroperitoneal glandular enlargements. The prognosis in these of

course is very poor. Such patients are not treated by surgery but only by radiotherapy to the region of the spinal cord involvement.

CASE II.—The second patient, A. B., a 66-year-old white woman, was first seen at The Barnard Free Skin and Cancer Hospital outpatient department, complaining of a lump about her left elbow region and the left axilla. One year previously she first noticed the left epitrochlear enlargement and several months later the firm nodes in her left axilla. Physical examination revealed a 1-cm. left epitrochlear node which was nontender and easily movable. There were several discrete 1-cm. nodes in the left axilla which were also easily movable. No other evidence of lymphadenopathy was present.



FIG. 44



FIG. 45

FIG. 44 (Case O. F. E.)—Anteroposterior view of lumbar vertebrae region showing absence of any block about the spinal cord 6 months following operation. Note laminectomy now extending to upper portion of sacrum.

FIG. 45 (Case O. F. E.)—Lateral view (roentgenogram) revealing lack of block about the spinal cord 6 months after laminectomy. Note laminectomy well along the midsacral region.

Operation.—On January 1, 1941, the left epitrochlear node was removed for microscopic examination and proved to be classical Hodgkin's disease. The patient was given deep x-ray therapy to the left axilla anteriorly and posteriorly. Three weeks following x-ray treatment there was complete regression of the left axilla nodes.

COURSE OF DISEASE.—On December 18, 1941, the patient was seen in the outpatient department where a 1.5 cm. node was felt in the posterior triangle of the left neck. She received further x-ray therapy to the discoidal nodes, with good response. On January 22, 1942, she began complaining of upper abdomen and right iliac region pains. On May 14, 1942, she had increased intrascapular

pains and physical examination revealed tenderness over the spinous process of the 6th thoracic vertebra.

X-ray Studies—Partial destruction of the 6th thoracic vertebra was present and there was an osteosclerosis of the 2nd and 4th lumbar vertebrae. Lip studies revealed partial block at the 6th thoracic vertebra. The Queckenstedt test was positive and the total proteins of the spinal fluid were 31 mg per 100 cc.

Neurologic Examination—No definite sensory level or motor impairment present but there were definite paraesthesias below the right and left breast.

Röntgenotherapy—After deep x-ray therapy to the upper thoracic region the patient improved temporarily but later her condition gradually became worse and she died 5 months later.

Involvement of the spinal epidural tissues by lymphomas may take place in one of several ways namely: (1) extension into the epidural space through the intervertebral foramina; (2) direct growth of epidural space lymphoid elements; (3) direct invasion of nearby vertebrae with eventual invasion of the epidural space; (4) invasion of epidural space from within involving the subarachnoidal space or the spinal cord proper, the growth continuing centrifugally; (5) direct invasion as a result of metastatic involvement of the vertebrae; (6) hematogenous and lymphogenous spread; and (7) implantation from distant sources along various levels in the epidural space. The first four of the above modes of spinal involvement are of most importance in a discussion of spinal epidural lymphomas of the malignant type.

In the past it was the general opinion that lymphoid tumors in the spinal epidural space were unquestionably the result of direct invasion through the intervertebral foramina from regionally involved lymph nodes. The presence of these lymphomas in the spinal epidural space seemed conclusively to indicate a widespread involvement throughout the body and the disease process in the spinal epidural space was considered to be a terminal manifestation. That this theory is a misconception seems well substantiated by more recent work, though even today many clinicians regard some of the malignant lymphomas such as Hodgkin's disease, lymphosarcoma and others of the same family as being primarily affections of the cervical lymph nodes.

SYMPTOMATOLOGY

The symptomatology of spinal epidural malignant lymphomas does not appear to differ essentially from that of other spinal cord tumors; the neurological findings likewise are similar to those of other tumors occurring within the spinal epidural space. It seems safe to affirm that at least 40 per cent of extradural growths give definite symptoms of root pain. There are instances of course in which the epidural tumor is located far from the nerve roots resulting in a delay of root disturbance.

Most frequently the initial recognition of abnormality by the patient is occasioned by symptoms of a paresthetic nature, i.e. burning, tingling, pins and needles, itching and sensation of cold—subjective

phenomena that are the direct result of irritation of the adjacent or nearby sensory nerve roots. The patient may not experience actual pain for an extended period after the beginning of the growth and the onset of paresthetic manifestation the extent of such delay being dependent on the location of the tumor.

The symptomatology is influenced by the following factors (1) location of the tumor with respect to segmental level (2) location of the tumor with respect to nerve roots (3) size configuration rate of growth and consistency of the tumor (4) relationship to anterior and posterior radicular arteries and veins (5) the existence or nonexistence of osseous involvement (6) degree of cord compression (closely related to number 3).

Ordinarily epidural lymphomas are elongated and of soft consistency which accounts for a long period of freedom from symptoms and the slight cord displacement. Physical examination may occasionally reveal a tender spinous process sometimes demonstrable only by deep pressure or percussion. The sensitive spinous process is usually located below the segmental level—the result possibly of irritation of the posterior sensory nerve root which supplies the corresponding vertebra. If a tumor is located at the 8th thoracic segment the spinous process of the 10th thoracic vertebra will be sensitive. In some cases where there has been a frank metastatic invasion of the vertebra from some other process the localization of the tenderness will correspond directly to the vertebra noted.

When cord compression is present it causes a disturbance in the transmission of nerve impulses up and down the cord as well as centripetally as demonstrated by our Case I. There will be a disturbance in the reflex mechanism and motor disturbances to areas supplied from cord segments below the level of the lesion and there will naturally be a loss of muscle power with the usual alteration of reflexes. Provided there is a compression of the segments epidural tumors will commonly produce fibrillary twitching not only in muscles undergoing atrophic change but also in those free from such change. This fibrillation in muscle can be traced directly to nerve root irritation. Flaccid paraplegia and loss of reflexes are typical symptoms of epidural tumors at the level of the cauda equina. This syndrome is not related to cord pressure but occurs when the nerves making up the cauda equina are involved directly.

THE ROENTGENOLOGICAL DIAGNOSIS OF SPINAL CORD TUMORS WITH SPECIAL REFERENCE TO EPIDURAL LYMPHOMAS

With the perfection of roentgenological equipment and increased knowledge of its use within the last 20 years earlier recognition and greater accuracy in identification and localization of spinal cord tumors have been made possible. In 1924 this method of diagnosis was not of great practical value as Carman and Davis then indicated. They re-

ported it to be accurate in the recognition of but 3 cases (2.6 per cent) in their series of 119 spinal cord tumors in which osseous changes were roentgenographically demonstrable. Today's figures taken from important clinics in this country indicate accurate localization in 50 to 60 per cent of the cases reported.

In spite of the unquestionable progress of lipiodolography which will be dealt with shortly, the simpler roentgenologic criteria as aids toward earlier diagnosis and localization of spinal cord tumors are not to be discarded. They may be divided into two classes which will be referred to as major and minor. As shown by Dyke, the most significant roentgenologic phenomena constituting the major class are (1) bone destruction, (2) appearance of the pedicles and evaluation of interpediculate distance between them, and (3) distortion of the paraspinal tissues. In the minor class are included (4) bone proliferation, (5) abnormalities of the intervertebral disks, (6) kyphosis and scoliosis, and (7) calcification.

It has been clearly demonstrated that about 80 per cent of the epidural spinal cord tumors may be visualized by means of the simpler roentgenologic methods. It is important, however, to bear in mind constantly that these methods depend on a thorough knowledge of the anatomical configuration of the vertebral canal, its variable measurements, the forms of the vertebrae, comparative study of all sections of the vertebral column, normal variations in adults, comparative vertebral measurements between adults, adolescence, and children, and lastly, possible congenital deformities of the vertebrae. Only when there is complete familiarity with these can such methods of diagnosis be followed with promising results.

Myelographic Studies in the Roentgenological Visualization and Localization of Spinal Epidural Lymphoid Tumors.—The most reliable procedure for the localization and investigation of cord tumors is *myelography*. Dandy of Baltimore (1919) first suggested the use of spinal air myelography as a means of localization of obstructive spinal lesions, but because of certain difficulties that were encountered, notably the lack of good definition and contrast on the roentgenograms, the method did not become popular. Eventually air myelography was largely discarded in favor of myelographic studies with lipiodol, a substance first developed by Dr. L. Lafay, a Paris chemist, in 1907 and originally used as a medicament in various medical conditions. As a diagnostic medium, lipiodol was used but little until Sicard and Forestier of France published their work (May 17, 1927) on its employment in the roentgenologic visualization of the space-occupying lesions within the vertebral canal. From this time on the medium was awarded more serious consideration.

With the experimental and clinical data available, there now exists little doubt that lipiodol, when injected into the spinal subarachnoidal space intracisternally or intracerebrally, produces definite leptomen-

noeal reaction fat encystment and possibly degenerative changes in the gray matter. For this reason numerous workers such as Young, Scott and Chamberlain prefer air myelography. Still others such as Nosik and Mortensen feel that in their hands thorium dioxide is the better contrast medium. Some workers have developed a technic for removing much of the lipiodol after its use when laminectomy is not to be performed subsequently. Since the diagnostic error with lipiodol for spinal cord work is less than with media of lesser densities (air, oxygen, helium) it is at present to be preferred but only if it will be removed either at operation or by one of the methods of aspiration developed by Klemme, Scott and Woolsey, Kubie and Hampton, Briesen and others.

INCIDENCE OF VARIOUS FORMS OF SPINAL EPIDURAL MALIGNANT LYMPHOMAS

The spinal cord may be the primary region of involvement and clinically and pathologically no other foci or lymphadenopathy may be found. On the other hand the cord involvement may be only a temporary stage in the life history of the tumor—that of temporary localization. Later a general systemic involvement may ensue. The prognosis nevertheless is good in cases falling into this group with no other clinical evidences of lymphadenopathy. Laminectomy followed by removal of the epidural tumor prior to the systemic involvement stage yields very encouraging results.

Conversely, Hodgkin's disease of the central nervous system may first involve cervical, axillary, thoracic, abdominal and inguinal lymph nodes before the nervous system involvement is clinically demonstrable. In this second group the nervous system manifestation is indeed a terminal event in the course of the disease and the prognosis is poor.

A number of recent studies of *Hodgkin's disease* have shown that from 10 to 27 per cent of clinical cases reveal evidence of central nervous involvement. In a recent survey of malignant lymphomas at The Barnard Free Skin and Cancer Hospital covering the 37 year period from January 1911 to June 1948, 34 cases of clinically and pathologically established Hodgkin's disease were found. Four of the 34 cases or 12 per cent, had clinical evidence of spinal cord involvement. The spinal cord involvement in the 4 cases became evident later in the course of the disease and was established only by clinical examination. In one case a definite spastic paraplegia was present while in another there were radicular pains bilaterally at the 8th and 9th thoracic dermatomes as a result of destruction of the body of the 6th thoracic vertebra.

Instances of involvement of the central nervous system by Hodgkin's disease far outnumber those of involvement by *lymphosarcoma*. While it is true that lymphosarcoma is not as common as Hodgkin's disease, it is also true that the ratio of lymphosarcomatous involvement

of the epidural space to the total number of lymphosarcomatous cases, based on necropsy studies is low indeed. Many otherwise comprehensive clinicopathologic reports on lymphosarcoma and other forms of malignant lymphomas contain no references to the spinal epidural space, the spinal cord or the brain. This seems odd in view of the fact that lymphosarcoma has been recognized as systemic since the latter part of the nineteenth century, and the omission makes it impossible accurately to evaluate the incidence of the systems involved. Approximately 15 to 25 per cent of patients with lymphosarcoma reveal neurologic symptoms and usually at necropsy 10 to 15 per cent show epidural masses as a result of regional invasion.

It is surprising to note how often spinal *leukemic* or *chloromatous* epidural masses are found at necropsy when clinically they are not suspected. Paraplegia resulting from leukemia and chloroma are not uncommon and their suspected rarity leads many clinicians to disregard them. George Dock in 1893 reported a case of chloroma in a 15 year old boy. Cranial nerve involvement was noted clinically but there was an absence of spinal cord disturbances. A complete post mortem study was carried out and showed among other findings that,

The most remarkable thing in this part is the transformation of the loose fat of the spinal canal (epidural space) which is totally converted into soft greenish masses some of them several centimeters in length and having only a loose connection with the dura. Many of these show small reddish areas in section.

Within the last decade sufficient evidence has been presented both clinically and pathologically to show a close relationship between lymphoid diseases especially myeloma, extraskelatal plasmoma and lymphosarcoma. Likewise during this same period much has been written of spinal epidural *plasmomas* in which neurologic symptoms referable to various segmental levels are first manifested. An analysis of such cases reveals an absence of osseous involvement and it is safe to say that in all probability the lymphoid growths took their origin from lymphoid elements in the spinal epidural space. Klemme in 1933 reported 5 such cases, the largest series on record where laminectomy and postoperative deep roentgen therapy brought the patient considerable alleviation and relief from neurologic symptoms. Two of his patients are living after 10 years. Since 1933 Klemme has had 4 additional cases of plasmoma of the spinal epidural space making a series of 9 patients.

A review of the literature revealed but one case of *germ follicular hyperplasia* involving the spinal epidural space. This case reported by Browder and de Veer in 1939 is the first of their series of 12 cases of lymphomatoid diseases involving the spinal epidural space.

The extensive and very informative article by Eichler and Rottmann (1928) on *mycosis fungoides* plainly indicates the eventual systemic nature of this form of malignant lymphoma and that the spinal epi

dural space may be involved in some of the patients. This is usually in the terminal stage of the disease.

TREATMENT

Even though it proves impossible to remove the tumor masses themselves, *laminectomy* may serve to relieve the pressure on the cord. Once the presence of spinal cord compression has been definitely established and a surgical intervention has been decided upon, there should be no delay in instituting it because any delay courts irreparable degenerative change in the cord or its structures and adversely affects the degree of return of normal function.

In a surgical consideration of the spinal epidural lymphomas, it is advisable to segregate the cases into two main groups: the first being those in which neurological symptoms are manifested initially and prior to any recognizable lymphadenopathy; the second, those in which spinal cord compression is a terminal manifestation.

When neurological symptoms are the first to manifest themselves, *laminectomy* should be performed as soon as the level of the tumor can be accurately established. Roentgenologic examination of the suspected region will sometimes reveal bony destruction of the vertebrae, but on the other hand, this may not be demonstrable and should not in any case contribute to postponement of *laminectomy* when cord compression is present.

In the second main group, in which neurologic symptoms develop as a late manifestation of the lymphomatous process, with subsequent spinal cord compression, surgical intervention is not indicated until *roentgenotherapy* has been given a thorough trial. Should satisfactory response to deep irradiation be lacking, *laminectomy* with exploration of the suspected region is then indicated.

In the group of cases in which neurologic symptoms are the first to manifest themselves, roentgen irradiation to the region of the vertebral column where the tumor was removed is commenced usually one week following *laminectomy*. Preferably, a right and left posterior oblique port is utilized directly over the operative site, using the following factors: 200 kvp, 18 ma, 50 cm F.S.D., filtration 0.5 mm Cu, intensity 85 r (with back scatter 20 by 20 cm) per minute, the port size depending upon the size of the tumor and area to be treated and degree of spinal epidural space involvement. The patient is treated daily, alternating from one side to the other, with daily dosage of 100 r until a total tumor dose of 900 or 1000 r is reached, ordinarily necessitating five to six treatments on each side, the depth dose being related to the paravertebral muscular thickness of the patient. Subsequent *roentgenotherapy* courses of treatment are administered as determined by later clinical observations. Ordinarily, following one course of deep x-ray therapy, the disease remains quiescent for several years.

In the second group in which the other signs of lymphomatous involvement are manifest prior to those of involvement of the spinal epidural space roentgenotherapy is routinely administered to the primarily involved regions. An involvement of the spinal epidural space usually a late manifestation may indicate vertebral disease. Roentgenotherapy is administered to the involved vertebral area the technic being similar to that above except that as a rule larger parts are covered in order to irradiate all of the affected mediastinal or lumbar lymph nodes. There is often vertebral destruction with occasional marked *malalignment of the vertebral column necessitating a plaster body cast*. If this is the case a posterior window may be cut over the vertebral area to be treated.

SUMMARY AND CONCLUSIONS

- 1 Malignant lymphomas of the spinal epidural space may be initiated clinically by neurologic symptoms such as paresthesus, root pains, anesthesia, flaccid or spastic paraplegia.
- 2 Malignant lymphomas may infiltrate the spinal epidural space as a terminal manifestation. The course of infiltration is more generally *along the intervertebral foramina as a result of mediastinal or retroperitoneal nodal involvement*.
- 3 The spinal epidural space may be involved in one of several ways by the malignant lymphomas namely
 - (a) Extension into the epidural space through the intervertebral foramina
 - (b) Directly from the epidural space lymphoid elements
 - (c) Direct invasion of nearby vertebrae with eventual invasion of the epidural space
 - (d) Invasion of the epidural space from within involving the subarachnoidal space or even the spinal cord proper and the growth continuing centrifugally
 - (e) Direct invasion as a result of metastatic involvement of the vertebrae
 - (f) Hematogenous and lymphogenous spread
 - (g) Implantation from distant sources along various levels in the epidural space
- 4 The symptomatology of the epidural lymphomas of the spinal cord is influenced by the following
 - (a) Location of the tumor with respect to segmental level
 - (b) Location of the tumor with respect to nerve roots
 - (c) Size configuration rate of growth and consistency of the tumor
 - (d) Relationship to anterior and posterior radicular arteries and veins
 - (e) The existence or nonexistence of osseous involvement
 - (f) Degree of cord compression—closely related to (c)

- 5 Accuracy in the localization and identification of spinal cord tumors has progressively increased during the past twenty years as result of
 - (a) Improvement of roentgenographic equipment
 - (b) Improvement of regional radiographic technic
 - (c) Evolvement of newer clinical neurological methods
- 6 Lipiodology yields a higher degree of accuracy when compared with air myelography in the diagnosis of tumors within the vertebral column
- 7 The consensus among neurosurgeons orthopedists and radiologists is that lipiodol when injected into the spinal subarachnoidal space intracisternally or intraventricularly produces definite leptomeningeal reaction with fat encystment
- 8 Air myelography lipiodology and thorium compounds are not to be considered altogether ideal for this type of work and are used only in lieu of an ideal substance yet to be discovered which would be completely absorbed and excreted without toxic manifestations
- 9 Laminectomy with removal of spinal epidural lymphoma followed by roentgenotherapy in cases where the spinal epidural space is the primary region of involvement offers moderately favorable prognosis
- 10 Roentgenotherapy by itself is indicated only when compression of the cord is a terminal manifestation the result of an infiltrating lymphomatous process from regional lymph nodes
- 11 Comparative studies of the plasmomas occurring in the upper respiratory region with clinical and pathological follow up of solitary myeloma and the spinal epidural plasmomas indicate that following laminectomy and roentgenotherapy the prognosis for epidural plasmomas is moderately good

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FLUORESCENCE STUDIES RELATED TO THE CANCER PROBLEM

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THE importance of fluorescence technics in the field of cancer research is so well recognized that they hardly need be reviewed. Less well known are the attempts to utilize fluorescence in the clinical study of the disease. Increasing interest in these methods in both the laboratory and the clinic is reflected in the increased number and the diversity of recent publications reporting the results of fluorescence studies.

Apparatus—Macroscopic observations of fluorescence may be made with simple inexpensive equipment. Self-contained units are available for this purpose† or one may be readily assembled from a suitable lamp autotransformer and reflector. Probably the best suited lamp is the type BH4 mercury vapor lamp‡ which has a filter incorporated into its jacket to absorb most of the visible light while transmitting a large fraction of the near ultraviolet radiation. An autotransformer‡ is required for the operation of this lamp from ordinary alternating current sources. The radiation from these lamps is rich in the near ultraviolet region and very poor in the shorter wavelengths so that there is no danger of ultraviolet burns even when the lamp is used for extended periods. Nevertheless the lamp should be shielded by a reflector so that the fluorescence of the observer's eyes does not interfere with his visual acuity.

Fluorescence microscopic studies require somewhat more complicated apparatus, some of which is not readily available at the present time. A tabulation of the equipment required may be found elsewhere¹. It is not within the scope of this review to describe the apparatus used for fluorescence study of special problems of the chemistry of carcinogens and for fluorescence spectrography. Detailed descriptions of technics usually accompany original articles or may be found in modern texts on luminescence.

CLINICAL STUDIES OF FLUORESCENCE

Fluorescence and the Diagnosis of Cancer—Many clinicians have examined suspected cancerous lesions in filtered ultraviolet light, hoping

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† Available from the X-ray Division, Westinghouse Electric and Mfg. Co. or Conit Glo Division, Continental Lithograph Corp., Cleveland, Ohio.

‡ Available from the General Electric Co. or Westinghouse Electric and Manufacturing Company.

that some characteristic fluorescence would enable them to say with certainty that the lesions were definitely benign or definitely malignant. Disappointment at what was visualized must have been the usual result for only a few positive reports have found their way into the literature. Policard³ observed a red fluorescence in rat sarcomas and attributed it to the presence of hematoporphyrin which he regarded as a decomposition product of blood resulting from bacterial action. Korbler⁴ found a similar fluorescence in certain human carcinomas and attempted inconclusively to prove that it was due to a primary metabolic difference between tumor cells and normal cells. Of more



Fig. 450

Fig. 450—Face of 80-year-old white man photographed in filtered ultraviolet light showing the intense fluorescence of hyperkeratotic preauricular lesions (white circles in photograph). The strong fluorescence of gray hair and the eye are normal.



Fig. 451

Fig. 451—Same subject photographed in ordinary light. The hyperkeratotic areas which are clearly evident in ultraviolet light cannot be distinguished here at all.

interest was the study by Thomas⁵ of the green pigment of chloromas and in the sympathetic ganglia of patients dying of chronic myeloid leukemia. This pigment fluoresced red and was demonstrated to be protoporphyrin. Gougerot and Patte⁶ claimed that basal cell carcinoma could be differentiated from spinocellular carcinoma by its fluorescence. To date these remain as isolated observations. The superficial fluorescence of malignant growths is neither constant enough nor sufficiently characteristic to be useful for positive diagnosis. In the study of lesions of the eye where fluorescence has proved of great diagnostic value it has been reported that epitheliomata show no differentiating characteristics in ultraviolet light.⁷

Precancerous Skin Lesions—Precancerous hyperkeratotic lesions fluoresce strongly bluish white in filtered ultraviolet light Fluorescence

Fig 452

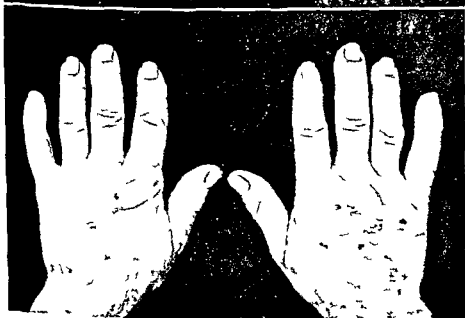
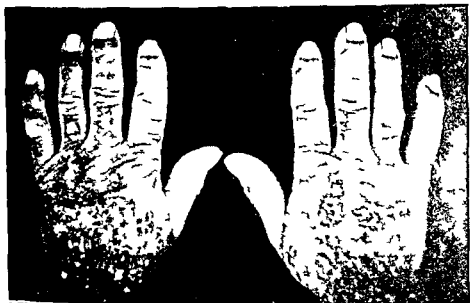


Fig 453

Figs 452 and 453—Hands of same patient photographed in filtered ultraviolet illumination (Fig 452) and in ordinary light (Fig 453). The dark spots in Fig 453 show areas that have already been cauterized. In Fig 452 some of these areas can be seen to have fluorescent hyperkeratotic borders about them. Many as yet untreated keratoses are also evident in the ultraviolet photograph. The strong fluorescence of the nails and palmar surface of the thumbs are normal.

photographs of many such precancerous lesions have been published in Buenos Aires by Roffo and his co workers⁸ who have attributed

the fluorescence to an elevation in the level of cholesterol in the local skin area. Although fluorescence alone does not differentiate these precancerous keratoses from benign hyperkeratotic lesions, it is perhaps unfortunate that the work is not better known. For an easy survey of the extent and precise location of even minute hyperkeratoses we know of no method that surpasses inspection in filtered ultraviolet light. Fluorescence photographs of the hands and face of a patient presenting multiple senile precancerous hyperkeratoses are illustrated in Figures 450 and 452. Figures 451 and 453 show for comparison the same areas as they may be seen in ordinary Mazda illumination.



Fig. 454—Case of *xeroderma pigmentosum* in 32-year-old white woman. Photographed in filtered ultraviolet light. Pigment spots appear dark against the grayish fluorescence of normal skin while radium and x-ray scars and multiple atrophic areas appear pure white in such illumination.

Melanin Deposits.—Melanin deposits in the skin vary from reddish brown to black in their fluorescence. The prominence of these patches against the strong fluorescence of unpigmented skin in ultraviolet light is well known to dermatologists. Areas that are so faintly colored as to be invisible in ordinary light may be easily visualized in this manner. Terry⁹ has illustrated such deposits in the skin in a recent publication. The dramatic appearance of the skin of a patient having advanced *xeroderma pigmentosum* is shown in Figure 454.

Fluorescence Diagnosis in the Clinical Laboratory—(a) *Serology*—About ten years ago hope was raised for a positive serological test for the presence of malignant disease after the report¹⁰ appeared that serum from patients with cancer decreased the fluorescence of uranine solutions while normal serum lacked this property. Further investigation revealed that this action was not limited to cancer serum specifically and also that some cancer sera lacked this activity. The test was inconclusive and has been dropped.

(b) *Urinanalysis*—Many investigators have attempted to find a correlation between the fluorescence of urine and the presence in the patient of cancer or other disease processes. Simon¹¹ who studied this question with considerable care concluded that there was no definite relation between the fluorescence of urine and the presence of malignant disease and that study of urine fluorescence was without merit as a test for cancer.

(c) *Pathology*—The advantages of examining gross pathological specimens have been indicated by many authors the most recent and one of the most enthusiastic being that of Herly¹ who claimed that the diagnosis of malignancy in cases of neoplastic breast disease by visual inspection of cut surfaces of operative specimens in filtered ultraviolet light was as accurate in his series as was the routine frozen section method. Should the technic prove as critical in other hands it may be expected to be of great value to hospitals lacking facilities for the frozen section method of diagnosis of surgical specimens.

The possibilities of fluorescence microscopy of pathological tissues have not yet been generally appreciated. Most tissues exhibit fluorescence to the degree that their general histological characteristics are easily recognized under the fluorescence microscope. In addition certain substances can be visualized in frozen sections that are perceived with difficulty by any other means. Popper and his co-workers¹² have published extensively on the vitamin A content of tumors and normal tissues using the strong but fading green fluorescence of the vitamin as their guide to its localization. With Cornbleet the same author¹⁴ showed the lakes of oil in a paraffinoma by fluorescence microscopy.

Fluorochrome dyes which may be used to stain components of tissues in dilute aqueous solutions permit the selective enhancement of the fluorescence of many components of tissues and thus extend greatly the range of fluorescence microscopy. Many such dyes were developed by Hantinger, Hamperl and Linsbauer. One of these Phosphor 3R, may be used in aqueous solution to stain lipids in frozen sections so that they fluoresce brilliantly silvery white in ultraviolet light. The method is rapid, accurate and completely free from the objectionable use of alcoholic solutions—a defect of all the Sudan techniques.

Another fluorochrome of great value to the diagnostician is Auramine O which may be used as an acid fast stain for tubercle bacilli¹ in the differential diagnosis of tuberculous granulomas from other

granulomas and neoplastic processes. Smears, frozen sections or paraffin sections may be examined by this method. The organisms are stained by the same procedure as used with the Ziehl-Nielsen method except for the substitution of Auramine O for carbol fuchsin. A 4-mm objective is useful in searching for points of golden fluorescence. With a 7-mm objective using a nonfluorescent mineral oil for immersion the organisms appear as golden fluorescent slightly curved rods. Sensitivity of the technic may be appreciated from the author's experience with a tuberculous granuloma of the tongue. Repeated examinations of biopsy specimens with carbol fuchsin failed to show organisms to confirm the suspicion that the process was tuberculous in origin. With the fluorescence technic the first section examined revealed three fluorescent rods with the form and staining characteristics of tubercle bacilli.

Photodynamic Activity and Solar Cancer.—As is well known, the chemicals commonly used for the experimental induction of cancer carcinogens—exhibit strong fluorescence in ultraviolet light and are capable of photodynamic activity. Whether this fluorescence and the accompanying photodynamic activity are factors in the physiological activity which they initiate has not been settled. The many attempts to answer this question have only clouded the issue. It is certainly true that exposure to light is not necessary for the activity of the compounds and some fairly good evidence has been presented that their activity is actually lessened if animals are exposed to solar radiation during the period of the carcinogenic treatment.¹⁸ These experiments, however, do not answer the question of whether photodynamically active substances in themselves weakly carcinogenic or noncarcinogenic may not at least accelerate the carcinogenesis due to exposure to light. Bungeler¹ was able to produce sarcomas in mice by exposing them to sunlight after they had been sensitized by the injection of hematoporphyrin, eosin or anthrasol. Hueper¹⁶ has reviewed this question in connection with pitch tar and anthracene occupational cancer and associates the photosensitization that these industrial hazards produce with their carcinogenic properties.

FLUORESCENCE ANALYSIS OF CARCINOGENS

Identification of the Carcinogenic Fractions of Tar.—Fluorescence analysis undoubtedly receives its greatest tribute in the fascinating though strictly scientific tale of the discovery of the nature of the pure hydrocarbons that can produce cancer. The roots of the story lie deep in modern medical history when Percival Pott in 1775 recognized for the first time the existence of a peculiar form of cancer occurring in chimney sweeps and traced it to the contamination of the skin with soot.

A century elapsed before other important contributions were made. Between 1885 and 1887 three reports appeared which were great stimuli to further work for they associated occupational cancer with tar.

(tar cancer) shale oils (paraffin cancer) and lubricating oils in the cotton spinning industry (mule spinner's cancer). During the next half century it was shown by Yamagawa and Ichikawa¹⁹ and Tsutsu²⁰ that coal tar would produce experimental tumors in animals and by Ploch²¹ and Kennaway²² that the higher boiling fractions of the tars were most active in this capacity. The latter investigator showed that carcinogenicity was restricted to certain types of tar and by the ingenious device of making a tar from pure acetylene that the carcinogenic material was a hydrocarbon.

Not until 1927 however was the key observation made that led to the solution of the problem. Then Mayneord³ noted that the spectra of the fluorescence of the carcinogenic tars had one common characteristic: all showed three bands in the violet at low dispersions. This vital clue led Hieger⁴ to study the fluorescence spectra of a number of polycyclic aromatic hydrocarbons. 1,2-Benzanthracene was found to give a spectrum closely related to the spectra of the carcinogenic tars. Cook took up the study at that point and studied a large series of benzanthracene derivatives. Soon Kennaway and Hieger⁴ had the opportunity to test the carcinogenic activity of certain benzanthracene derivatives whose synthesis had recently been worked out by Clar. The first to give positive results and therefore the first pure hydrocarbon known to exhibit pronounced carcinogenic activity was 1,2,5,6-dibenzanthracene. In all this work by Mayneord, Hieger, Cook and Kennaway the fluorescence spectrum was in the words of the latter investigator "the single thread that led all through this labyrinth." The same thread led Hieger⁵ through the tedious process of concentrating the active carcinogenic agent in coal tar pitch: a fraction soon shown to be identical by its fluorescence spectrum with 3,4-benzpyrene. This proved to be a very powerful carcinogen.

Quantitative Determinations of Carcinogens by Their Fluorescence—Many workers have shown that the intensity of fluorescence of a strongly fluorescent substance may be used as a measure of its concentration even in the presence of certain impurities provided the impurities are themselves neither strongly fluorescent nor capable of interfering with the fluorescence of the substance to be estimated. Such measurements may be made by photo electric methods (fluorimetry) or by densitometry of fluorescence spectra (quantitative fluorescence spectrography).

Fluorescence of the Metabolites of Carcinogens—Many studies have been made on the manner in which the animal body disposes of pure chemical carcinogens after they have been injected. Again fluorescence analysis has been of service in identifying the metabolites in extracts of tissues, bile, feces and urine. Groups of workers headed by Peacock⁶ and by Berenblum⁷ have been responsible for much of the investigation of this phase of experimental carcinogenesis.

FLUORESCENCE STUDIES OF EXPERIMENTAL CANCER

Localization and Persistence of Carcinogens in Animal Tissues—(a) Injected Carcinogenic Chemicals—The persistence of carcinogenic compounds in tissues depends on many factors not the least important of which is the vehicle in which they are introduced. The solvent plays a very important role in determining the persistence of carcinogenic chemicals injected into subcutaneous tissues. If the solvent is rapidly absorbed by the tissues the carcinogen disappears quickly; if the solvent remains the carcinogen persists too. It has even been suggested that the presence or absence of fluorescence of the carcinogen at an interval of weeks or months is a good measure of the capacity of the organism to dispose of the *solvent* not of the carcinogen itself.⁵

(b) Superficially Applied Carcinogens—The same criticism hardly applies to the study of carcinogens applied to the skin in highly volatile lipid solvents. Becl and Peacock⁹ noted that the macroscopically visible fluorescence of 3,4-benzpyrene disappeared from the skin of mice within 4 days after a single application. Hieger⁸ noted that the fluorescence of benzpyrene disappeared within 3 weeks after application no matter how many times it had been applied previously. In this hospital Dr. W. Cramer and the author³⁰ have studied the persistence of methylcholanthrene in mouse skin by fluorescence microscopy. It was found that the carcinogen was selectively absorbed by the sebaceous glands and the free lipids of the keratinized epidermis. The sebaceous glands underwent rapid degeneration and poured out their sebum and dissolved carcinogen onto the surface of the epidermis. With the thickening and differentiation of the epithelium a heavy keratin layer flaked off it from 4 to 8 days carrying the strongly fluorescent carcinogen with it and leaving no obvious methylcholanthrene in the skin.

These studies pointed the way to the study of the function of the sebaceous glands in experimental carcinogenesis. It was soon found that a powerful carcinogen, methylcholanthrene, was almost completely robbed of its injurious and cancer-producing properties if it was applied in anhydrous lanolin, a solvent resembling the secretion of the sebaceous glands.³¹

Doniach, Mottram, and Weigert³ in England have approached the problem of persistence of carcinogens in skin from another direction. Using chiefly spectrographic methods they determined that 3,4-benzpyrene leaves the skin within 7 days (except for the hair which still showed traces for 2 to 3 weeks) after being painted on in benzene solution. Their technique also showed that a new compound which fluoresced blue was formed in the skin as a result of this treatment. This was apparently a breakdown product of the carcinogen and persisted for approximately a month after a single painting. This metabolic product could be extracted by a dilute sodium hydroxide solution. We have confirmed these findings in this laboratory for another carcinogen, methylcholanthrene.

Natural Occurrence of Carcinogens—The structural similarity of the methylcholanthrene molecule and that of naturally occurring bile acids has given rise to the conjecture that this carcinogen might actually be synthesized in the animal body. Attempts to extract substances from cancerous tissues and from uninvolved tissues of cancer patients have as yet yielded no compound exhibiting the characteristic fluorescence of this or any related carcinogenic compound in spite of reports to the contrary.^{33, 34} Although previous work has given negative results the question still holds interest for many investigators. Also of interest but outside the scope of this review is the question of chemical interrelationships of the carcinogens and the sex hormones and adrenal substances.

Miscellaneous Associations of Fluorescence and Cancer—Another recently reported and as yet unexplained correlation of fluorescence and cancer susceptibility is the finding of Figge Strong and others³ that strains of mice that had a high incidence of spontaneous mammary cancer also had Harderian glands that fluoresced strongly red in ultra violet while these glands did not fluoresce red in strains that had a low incidence of such cancer.

Unpublished observations by Cramer and the author³⁶ include data that relate further the fluorescences in skin with the carcinogenic process initiated by methylcholanthrene. One of these is that mast cells accumulate beneath the chronically hyperplastic epidermis and acquire modified reactions to toluidin blue and other stains. These cells normally are at best weakly fluorescent but in such skin many of them become strongly luminescent under the fluorescence microscope. Hyperplastic epidermis also shows fluorescence that the normal prototype lacks. Fluorescence spectrographic studies of the substances responsible for these changes are in progress.

Throughout the history of cancer study there appear again and again observations that seem to associate the carcinogenic process with fluorescent substances. These findings have led even to the proposition that the degree of carcinogenicity of a compound was directly proportional to its fluorescence in ultraviolet light. This bubble burst when critical scientific measures were applied.³⁷

Only time will tell whether all these observations that relate the development of cancer to fluorescent substances are accidental coincidences or whether here as in the isolation of the pure carcinogenic hydrocarbons they point the way to a solution of the whole fascinating problem. Will cancer research through fluorescence studies find light out of darkness?

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CANCER STATISTICS FOR MORTICIANS AND FOR CLINICIANS

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THE Statistical Method is one of the few available for the investigation of the general features of cancer as it affects man. It requires not so much a deep knowledge of statistics as an intimate knowledge of the clinical and pathological aspects of cancer, careful observation and recording of all the relevant facts and a modicum of common sense.

The immediate problems which cancer presents to the clinician are concerned with diagnosis, prognosis and treatment. In these fields he is impressed by the infinite variety in which the phenomenon of malignancy manifests itself. Not only does cancer attack almost every organ and tissue in the body, but even in one and the same organ every individual neoplasm that develops seems to follow its own laws. In short every neoplasm may be looked upon as a biological individual. To be sure they all have in common the property of infiltrative autonomous growth or they would not have been diagnosed as cancer. But there are other features which malignant neoplasms share but which are not readily detectable by the clinician preoccupied with the study of individual cases and impressed by the apparent capriciousness of the disease.

These other entities emerge only when the records of large numbers of patients are analyzed statistically. When such results are interpreted in the light of our knowledge of cancer gained by the experimental study of the disease in animals, conclusions can be drawn revealing features of cancer in the human subject which add important information to our knowledge of the various etiologic factors concerned in the development of cancer in man and which may also on occasion assist in the difficult task of an early diagnosis of the disease.

GEOGRAPHIC INCIDENCE—CRUDE FIGURES VERSUS RATE

As material for such large numbers of records of cancer patients two sources are available. One is represented by the figures for the mortality from cancer based on death certificates collected by the various states and published annually by the Bureau of Census. The other available source is found in the records of patients treated in various large hospitals and clinics. The data collected from these sources, i.e. the number of persons dead from cancer as gathered from the official mortality statistics and the number of patients treated for cancer in hospitals or by individual clinicians, are not in themselves statistics.

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any more than a heap of bricks is a house. They are merely the raw material—the crude figures—as the statisticians call them—which have to be analyzed by relating them to a *frame of reference*.

An example will make this point clear. If the statement is made that there are more telephone subscribers in New York than in Cleveland, figures can be given which establish its truth conclusively. Nevertheless the statement is meaningless. For it may be seen at once that there are more people living in New York than in Cleveland and that in order to impart a meaning to these figures the rate of telephone subscribers for an equal unit of people—say 100,000 persons—must be calculated. This equal unit of population is the *frame of reference* and the figure obtained is the *rate*—as against the *crude figures*.

The same argument holds good when we compare the mortality in New York and in Cleveland. In 1936 71,375 white persons died in New York as against 93,791 white persons in Cleveland. These crude figures do not prove that New York is an unhealthier place to live in than Cleveland, in the sense that the chance of dying is greater for a New Yorker than for a Clevelander. In order to decide that point the rate has to be calculated for an equal unit number of living persons. What sauce for the goose? total mortality is sauce for the gander. Cancer mortality. The crude figures for the cancer mortality in 1936 are: New York 10,306 persons; Cleveland—1,271 persons. The cancer mortality rate per 100,000 inhabitants—the term used by statisticians's persons living—is higher almost the same 141 for New York and 145 for Cleveland. For reasons which will be presented later these figures have yet to be corrected for possible differences in the age-constitution of the two populations.

We shall find presently that statements are made in the medical literature both in textbooks and in original contributions using crude figures for a comparison of the frequency of cancer in two different populations. Could it be said that deaths either from all causes or from cancer are more frequent in New York than in Cleveland on the basis of the crude figures just given? A statement to that effect could be made on oath in a Court of Law without committing a perjury. If we mean by frequency the number of deaths per day it would be true. Such a statistical fact might interest an undertaker looking for business. As we shall have to refer again to this interpretation of frequency statistics it will be called *undertaker statistics*.

To the medical man the term frequency as applied to the incidence of a disease in different populations has a different meaning. He wants to know the relative proportion of persons suffering from a given disease in a population. In other words he wants to know the *rate of mortality*—or *morbidity*, as the case may be—from a given disease. From the medical point of view, therefore, the crude figures by themselves are useless. In view of the touching belief that many people have in the reliability of figures—figures cannot lie—it is interesting to note that the same set of figures can be used to lead to two very different conclusions. Cancer is eight times as frequent in New York as in Cleveland and Cancer is just as frequent in New York as in Cleveland. Both these statements can be said to be true and they can be said to be false according to the frame of reference used in con-

nection with the word frequent. It is a lesson emphasizing the importance of semantics—the science of the meaning of meanings.

SEX AND AGE INCIDENCE

The same points hold true when a comparison is made of the cancer mortality in the two sexes—the sex incidence of cancer—or between different age groups of a population—the age incidence of cancer. For the numbers of the male population and of the female population in the United States are not equal nor are the numbers of persons living in the different age groups. Everybody knows that the number of persons comprising a large population in which different age groups are compared diminishes as we proceed from childhood through adult life to old age. A comparison of the cancer incidence in the several age groups refers therefore to groups of living persons comprising different numbers. For this reason the crude figures for these different groups cannot be compared directly but have to be transformed into rates for an equal unit number of persons living in each age group. When this is done it is found that the conclusions drawn from the crude figures are not only meaningless but grossly misleading.

All this is so obvious that it may be asked why it should be necessary to flog a dead horse. The answer is that the horse is not dead but still very much alive. Most textbooks on cancer whether written by clinicians or pathologists make the mistake of discussing the age incidence of cancer with reference to the crude figures and not to the rate and the same mistake is to be found in numerous papers published in the cancer literature. Needless to say this mistake is not made by statisticians. The difference between the crude figures for the cancer mortality and the figures for the cancer mortality rates and the importance of distinguishing between the two is clearly illustrated in the accompanying table taken from data published by the Bureau of Census for the year 1940 and referring to the white population of the United States. Data have been selected from the tables for four organs: breast and uterus for women; prostate for men; and stomach for men and women separately. They have been chosen because they serve to illustrate a number of important points and because the disease in these four organs is numerically important.

What direct comparisons of the data given in the table are justifiable? The crude figures allow of a direct comparison only if the crude figures refer to populations equal in numbers but not if they refer to populations differing in numbers. It is permissible to compare the crude figures for the mortality in women from breast cancer from uterine cancer and from stomach cancer. Similarly it is permissible to compare the mortality figures for prostate cancer and for stomach cancer in men. In these two groups the crude figures refer to populations equal in number: in the first group all the women living in the United States; in the second group all the men living here. But no

COMPARISON OF CANCER MORTALITY AND OF MORTALITY RATE BY AGE FOR BREAST, UTERUS, STOMACH, AND PROSTATE FOR 1940

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Ogan	M nality	Age Gro ps												T ¹ (All Ages)	
		0-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79		80-84
East	Crud figures	21	74	277	559	1012	1326	1760	1778	1909	1460	1087	756	209	14347
	R t per 100 000	0.1	1.5	6.0	13.1	25.7	41.4	54.5	67.4	87.4	98.3	119.9	10.2		21.6
Gutu	Crud figures	56	176	452	805	1239	1631	1813	1805	2212	2402	835	493	168	71703
	R t per 100 000	0.3	3.5	9.8	18.9	31.2	44.2	56.8	68.5	79.3	96.1	108.5	117.8		24.3
Presta	Crud figures	1	2	4	8	30	81	182	461	936	1376	2244	105	3.1	8104
	Rat pe 100 000	0.1	0	0.1	0.2	0.8	2.1	5.3	16.5	41.9	97.7	159.3	277.5		14.1
S mach	Crud figures	20	38	72	117	344	702	1102	2704	22.0	2.89	1014	1026	313	11900
	R t per 100 000	0.1	0.7	1.6	3.3	9.1	18.3	34.6	61.1	9.4	14.1	212.4	287.9	25.1	9261
		2	0.7	1.4	2	5	1	8.6	32	52.1	124.2	2	2	25.8	

direct comparison can be made between the mortality figures for gastric cancer in men and in women because the male white population is not equal in number to the female population but exceeds it by about 1 000 000. The conclusion can be drawn for instance from the crude figures that in women the mortality from breast cancer or from uterine cancer far exceeds the mortality from stomach cancer. The combined mortality from breast cancer and uterine cancer is in fact responsible for over 37 per cent of the total cancer mortality in women which amounts to 76 674. These two organs may be said to dominate the cancer mortality in women. Since in both these organs cancer can be diagnosed in its early stages with the result that a permanent cure can be obtained—and is being obtained in a considerable percentage of cases—it is clear that an increase in the number of women seeking medical advice at an early stage of the disease would be reflected as a material diminution in the total cancer mortality. In men with a total cancer mortality of 71 109 the only organ belonging to the genitourinary system that is numerically important from the point of view of the cancer mortality is the prostate. But in men the mortality from gastric cancer far exceeds that from prostate cancer.

The same conclusions would of course be arrived at from a consideration of the figures for the mortality rates. The advantage of using rates is that they all refer to populations equal in numbers (100 000 in the table) and that therefore all the figures are directly comparable. We can for instance compare directly the rates of the cancer mortality in the different states of the Union with each other or with the rates for those European countries for which reliable cancer statistics are available. We find then that a similar dominating position of breast cancer and uterine cancer in the cancer mortality statistics for women appears also in England but in Holland or the Scandinavian countries the rate for gastric cancer in women is much higher and for uterine and breast cancer much lower than in the United States or in England. In spite of a detailed investigation undertaken by a committee of experts organized by the League of Nations no adequate explanation has been found which would account adequately for this interesting difference in the incidence of cancer of the breast and uterus.

But if now we proceed to investigate the frequency with which cancer attacks different organs at the various ages the crude figures cannot give any correct information because as pointed out earlier the populations comprising the various age groups all differ numerically from each other. If we argue from the crude figures we would have to say that cancer of the uterus attacks women most frequently at the ages of 50 to 57 cancer of the breast at the ages of 60 to 64 and similar inferences would have to be drawn for the other three organs. This is on a par with saying that cancer attacks the inhabitants of New York more frequently than the inhabitants of Cleveland. That

is the undertakers conception of frequency. But such statements are actually made in many textbooks and papers and such crude figures are described there as representing the age incidence of cancer.

If on the other hand we base our conclusions on the mortality rates we find for almost every tissue or organ the greatest frequency in the oldest age group. This means that the chance of a person being attacked by cancer steadily increases and reaches a relatively high figure in the oldest age group. That is—or should be—the clinician's conception of the frequency with which cancer affects a population at different ages because it shows the true relationship between age and the onset of the disease. This relationship which is the same for practically every organ or tissue is the true age incidence of cancer and to apply this term to the crude figures is not only mistaken but grossly misleading. The significance of this relationship is perhaps most clearly indicated by the fact that one half of the total cancer mortality falls on the group of the population that is aged 65 years or more although that group represents only from 6 to 7 per cent of the total population.

The rates that is the true age incidence of cancer indicate what chances exist for the development of cancer in a person in a given age group within a given period and in a given organ. Thus for breast cancer it has been calculated that the chance per 1000 individuals of a woman developing breast cancer within the next 10 years increases with increasing age as follows:

Age	Chance per 1000
At 35	28
45	55
55	75
65	81

The likelihood at age 45 is double and at 65 triple that existing at 35. The same relationship holds true for the relative frequency with which malignant and nonmalignant lesions of the breast were found to occur at different ages in a series of 181 cases. These figures expressed in percentage are as follows:

Age	Benign and Other Nonmalignant Lesions	Malignant
Below 30	100	0
30-40	84	16
40-50	60	40
50-54	15	85
55-59	8	92
60-64	5	95
Over 65	0	100

Figures such as these suggest that a different approach should be made in attempts to educate the public to seek medical advice early. At present the public is told to consult a doctor at once when a lump is felt in the breast because it may be cancer. It might be advisable to

follow a suggestion made by my colleague Dr Major Seelig to change the wording to it may *not* be cancer

Factors Determining Higher Incidence of Cancer With Advancing Age
—Coming back to the chances at different ages of developing cancer the figures for other organs may be higher or lower than those for the breast but their relative differences are of about the same order. There is no other numerically important disease which manifests this extraordinarily rapid increase of the incidence with advancing age. It manifests itself also in the incidence of cancer in all species of animals for which a sufficient number of data have been available. This age incidence represents therefore a characteristic feature of the disease that has to be accounted for by an adequate explanation. Formerly it was interpreted as indicating that senility of the tissues was a factor favorable to the development of cancer. The study of experimental carcinogenesis has put this explanation out of court because it has been shown that cancer can be induced just as readily and sometimes more readily in young as in old animals. Our knowledge of the factor determining the onset of cancer in man has been dealt with elsewhere.¹ Here we need only to state that the time necessary to induce cancer varies inversely with the strength of the carcinogenic stimuli to which our bodies have been exposed during life. Among these stimuli some are intrinsic others extrinsic. The carcinogenic stimuli are numerous and vary from organ to organ. Among the organs that respond to extrinsic stimuli are the skin and upper alimentary tract down to and including the stomach, a numerically important group.

As long as senility of the tissues was believed to be the determining factor the outlook was bleak. For we cannot escape from senility. But we can escape from extrinsic carcinogenic factors and by thus weakening their influence it becomes possible to consider the possibility of a delay in the onset of cancer. Such a delay would be a great advance in our fight against cancer. It would be more valuable than an advance in the number of patients cured by operation at an earlier age. Is there any evidence to justify such an outlook? In the statistics for England and Wales for 1934 a comparison between the cancer mortality in the period from 1911 to 1920 and in the two year period 1933 and 1934 shows that there has been a diminution in the rates for age groups from 35 to 65 for such organs as the skin, the tongue and esophagus but not for the stomach and lower part of the alimentary tract. The rates for the uterus also show a decrease in all age groups while the rates for breast show an increase in all age groups. In those organs whose rates show a decrease in the age groups below 65 there is an increase in the groups above 65 so that this delay does not necessarily indicate a diminution in the total cancer mortality.

The investigations of Dublin and Lotkin⁴ for the same period in the United States show a remarkable similarity in the trend of mortality for essentially the same groups of organs. The opposite trend of the

cancer mortality for the uterus and for the breast—an increase in the age groups for the breast a diminution in the earlier age groups for the uterus—may perhaps be correlated with the diminution in the birth rate. Childbearing has an opposite effect on these two organs. Multiparous women have a higher incidence of uterine cancer than nulliparous women while for breast cancer the relationship is reversed. The delay in the onset of cancer of the upper alimentary tract may find an explanation in the fact disclosed by Stevenson that the upper alimentary tract is more frequently attacked by cancer in the lower social classes than in the higher ones. As pointed out in an earlier paper³ this probably is due to differences in the habits and modes of life in the different social classes especially along the lines of hygiene and diet. An improvement of these habits in the lower social classes along those lines may therefore be expected to lead to a diminution in the incidence of cancer of the upper alimentary tract. Whatever the explanation of this phenomenon of delay may be the fact that it is taking place in a number of important organs is a most promising sign. It indicates that the control of cancer is not limited to an improvement in the early diagnosis of the disease but can be made effective also by delaying its onset. After all none of us care very much of what disease but at what age we die. Most of us would rather die of cancer at 70 than of some other disease at 55.

PERIOD INCIDENCE

When we make a comparison between the cancer mortality at different times say at 1910, 1920, 1930 and 1940 we face again the problem of having as the frame of reference populations differing in numbers in the country as a whole there has been a great increase in population. In this case however it is no longer sufficient to calculate the rate from the ratio of the number of deaths from cancer over the total population. For there has also been a great change in what is technically called the age constitution of the population. This age constitution refers to the relative proportion of persons living in the different age groups. Taking as an example the three years 1910, 1930 and 1940 and dividing the population into three age groups—the group 0-44 in which the total cancer incidence is low whether considered as crude figures or as rates, the group 45-64 in which it is high considered in crude figures and the rate is beginning to rise and lastly the group 65 and over in which the rates reach their maximum and are so high that in 1940 as stated previously one half of the total cancer mortality falls on this group—Dublin and Lotka give the following figures for the percentage distribution of these three age groups:

Age	1910	1930	1940
0-44	8.0	77.1	73.5
45-64	13.7	17.5	20.2
65 and over	4.3	5.4	6.3

The relative proportion of the oldest group 65 and over has therefore greatly increased during this period. In view of the fact that this group shows the highest frequency of cancer this *shift in the age constitution* must necessarily increase the crude figures for the cancer mortality both for the total mortality and for the individual organs. As pointed out earlier the crude figures are misleading when they are given for the different age groups of patients dead from cancer in any one year. They are doubly misleading when they are given for different years. If a comparison has to be made for different years the shift in the age constitution of the population has to be eliminated by a statistical device which involves a recalculation of the crude figures actually collected for an arbitrary standard population having a fixed age constitution.

HOSPITAL AND CLINIC STATISTICS VERSUS OFFICIAL CANCER MORTALITY STATISTICS

The point always to be remembered is that a correct interpretation of the crude figures for the deaths from cancer requires as a frame of reference the number of persons living analyzed according to age and to sex. Such data are available in the census for cities, counties or states, i.e. the same areas for which the data are collected concerning the causes of death.

If the reiteration of this argument is wearisome to the reader it is nevertheless necessary because it is highly relevant to a discussion of the claim made by many pathologists and clinicians that cancer statistics obtained from hospitals and clinics are preferable to the official cancer mortality statistics. The argument put forward in support of this claim is that the diagnosis of cancer is more accurate in hospitals and clinics than in the population as a whole where the inaccuracies are stated to be such as to make the statistical data of no or little value.

It may be admitted that the official cancer mortality statistics are numerically inaccurate. But these inaccuracies are not capricious or haphazard. They affect mainly those organs in which it is difficult to diagnose cancer—the so called inaccessible organs—for example the stomach and the intestines. Since these organs present difficulties in recognizing the presence of cancer the errors in the figures for these organs are due to an underdiagnosis, that is to say the recorded cancer mortality is considerably below the actual cancer mortality. But this error remains fairly regular throughout the years especially when communities comprising several millions of people are under consideration. The figures then show only a slight but steady increase in the cancer mortality over long periods of years due to gradual improvements in the diagnostic methods and in the facilities available for medical examinations. One finds accordingly that for different communities the figures for the recorded cancer mortality in the inaccessible organs vary greatly with the presence or absence of the facilities available for diag-

nosis. In the southern states of the Union for instance the number of medical men per unit number of population was before the present war only from one third to one half that for many of the eastern and northern states indicating a lack of diagnostic facilities in the southern states that is conducive to an underdiagnosis. The recorded figures for the mortality from gastric cancer in the southern states are only one half of the figures recorded in those northern and eastern states. They are in fact much lower than any figures recorded in those European countries with reliable cancer mortality statistics. Considerations such as these suggest the possibility that the low incidence of gastric cancer in the southern states is due partly at any rate to an underdiagnosis. For statistical investigations that involve the interpretation of the official cancer mortality figures one would of course select those communities, cities or states in which errors due to underdiagnosis are least likely.

Granted then that the official cancer mortality statistics are subject to errors they are limited mainly to an underdiagnosis in the inaccessible sites. This does not justify the wholesale condemnation of these data. The figures for the mortality from gastric cancer may be incorrect numerically in being too low but these errors will be of the same relative order for men and for women so that the lower incidence of gastric cancer in women can be accepted as a fact. They will be of the same order also for the various age groups so that we find the same rapidly increasing figures with age—the true age incidence—for cancer of the inaccessible organs as for the accessible organs, in which the errors due to these diagnostic difficulties are of a much lower order of magnitude. What in fact impresses the student of the official cancer mortality statistics when they are interpreted correctly is the essential similarity of the result. The sex incidence, the age incidence, the organ incidence all show essentially the same features, when a comparison is made between different communities or even between different countries which are able to present reliable cancer statistics.

On the other hand when one studies many of the statistics presented by different hospitals or clinics one is impressed by the variability and the confusion of the data analyzed for organs or for ages. They differ from one another. As explained earlier the statements made concerning the age incidence are meaningless if merely the crude figures are given and grossly misleading if their interpretation is attempted. The exclusion of diagnostic errors is no protection against a misinterpretation of the data available. The explanation is that the data supplied by a single hospital have no frame of reference by which they can be interpreted. A hospital population is a selected population. The patients that pass through the hospital do not represent the incidence of the disease in the various age groups, organ groups or sex groups.

as it affects the population as a whole. With regards to analyses of the clinical material the clinician or the pathologist is thus restricted to the use of the crude figures. That means he uses what has been described earlier as undertaker statistics.

This criticism must not be taken to mean that the statistical investigation of cancer in man on the basis of clinical data is of no value. The relationship between the two lines of investigation may be summarized by saying that the mortality statistics and the data obtainable from clinical observations do not compete with each other; they complement each other. The information available from either source is limited in its scope but different in its subject matter. It might be said that while the mortality statistics give us a picture of the essential features of the disease, clinical observations contribute the no less important knowledge of its finer details.

The discovery of the various forms of *occupational cancer* we owe to clinical observations. The first discovery of an occupational cancer was made 170 years ago by Percival Pott who described chimney sweeps' cancer. It was quoted in medical and pathological textbooks as a curiosum of cancerology but its fundamental importance as establishing an etiologic correlation between cancer and an extrinsic agent was not recognized. One hundred years later the clinical observations of Bell established a similar occupational relationship for the skin cancer of the shale oil workers in Scotland. As a result subsequent clinical observations led to the discovery of other occupational cancers. As an important example may be mentioned the work of Unna which established exposure to sunlight as an etiologic agent for skin cancer. The subject has been dealt with fully in an excellent monograph by W. C. Hueper.⁶

The difficulty encountered in understanding the significance of these discoveries was due to the fact that in these occupational cancers only a small fraction of the persons engaged in an occupation developed cancer and among these were some who had left the occupation many years before cancer developed while others who had continued in the occupation remained free from cancer. When 150 years after Pott's discovery some of these extrinsic agents were applied to the skin of rabbits and of mice it was found that the extrinsic agents capable of inducing skin cancer in man induced also skin cancer in animals. Then the difficulty mentioned above was resolved. In animals as in man this process of carcinogenesis is strongly conditioned by two factors: the factor of susceptibility and the factor of time. As regards susceptibility it is sufficient to say here that the application of a carcinogenic agent to a number of animals of the same species, the same age, the same sex and living under identical conditions produces cancer in only a fraction of such animals while the rest remain free from the disease. We shall encounter this factor again in discussing the familial incidence of cancer.

The importance of the second factor manifests itself in the fact that the development of cancer requires a comparatively long period of time amounting to a considerable fraction of the life span of a man or of an animal. The experimentally established fact that cancer requires a long period of induction amounting to a considerable fraction of the life span of an animal together with the finding that cancer can be induced in young animals as readily if not more readily as in old animals made it necessary to abandon the explanation of the characteristic age incidence of cancer as being due to senility of the tissues acting as a predisposing factor. A new conception emerged which explains the rapidly increas-

ing frequency of cancer incidence with increasing age on the basis of the time it has to elapse before carcinogenic stimuli become effective. This time period is the more prolonged the weaker the carcinogenic stimuli are.

The discovery of this long period of induction affected also the scientific conception of the precancerous condition. This conception had been formulated 40 years ago by dermatologists. It had been possible for them to do so because the whole process of carcinogenesis is visible in the skin and can be followed there. But the validity of this conception as a general or frequent occurrence in cancer of other organs was contested by pathologists. Cancer was believed to develop suddenly. The experimental study of carcinogenesis made it possible to show that during this long period of induction the tissue subjected to the action of a carcinogenic agent undergoes characteristic morphological changes. Once the validity of the conception of precancer was established, search was made for the existence of such conditions in man, and the existence of numerous precancerous conditions in various organs has now been established. The existence of such precancerous conditions is of clinical importance because their recognition and treatment may prevent a subsequent development of cancer.

Certain diseases may be responsible for the development of such conditions. An example is syphilis, which has been known to favor a subsequent development of cancer on the tongue. An investigation designed to determine whether the incidence of cancer in other organs was similarly affected by a previous syphilitic infection was carried out by Fry in 1939. He arrived at the conclusion that syphilis plays no direct or very important part in the production of cancer.

A recent re-investigation of this problem by L. Levin and his associates from the Division of Cancer Control, New York State Department of Health, led to the discovery that in women with uterine cervix cancer syphilis was found about 4 per cent of the patients that is about three times as frequently as in women with cancer of other sites including the body of the uterus. In males with tongue cancer syphilis was found to be present five times as frequently as in males having other forms of cancer. Cancer of the tongue is not numerically an important cause of death. But cancer of the uterine cervix is responsible for about 15 per cent of all deaths from cancer in women. In actual figures the number of deaths in the United States from cervical cancer amounted to about 15,000 women every year. Since syphilis is a preventable disease the numerical significance of the discovery of this relationship from the point of view of the prevention of cervical cancer in 4 per cent of these women is readily appreciated.

FAMILIAL INCIDENCE

The term familial incidence of cancer is preferable to the term inheritance of cancer because what is inherited is not cancer as such but an increased susceptibility to cancer. Until recently the existence of a familial incidence was a numerically important phenomenon was denied—sometimes vehemently by pathologists and clinicians. They based this opposition on considerations embracing cancer of all organs. Beginning with patients who had suffered from cancer of any one organ including the skin they found that statistically the relatives of such a patient did not suffer more frequently from cancer of any one organ than the rest of the population. The application of the method of genetics to the experimental study of cancer made it possible to produce by inbreeding strains of mice exhibiting a high percentage of spontaneous malignant neoplasms in one particular organ such as the breast or in other strains the lungs.

When these findings were applied to the study of cancer in man the problem of the familial incidence of cancer was approached from a new angle. Cancer patients were grouped together according to the affected organ and the incidence of cancer in their relatives was investigated. It was found that the female relatives of women suffering from breast cancer had a higher incidence of cancer of the breast than the rest of the female population but did not have a higher incidence of cancer of the uterus or of any other organ. Nor did their male relatives show a higher incidence of cancer. Similarly the relatives of women with uterine cancer showed a higher incidence of cancer of the uterus but not of the breast or of any other organ.

The familial incidence is thus restricted to one particular organ—the so-called homotype organ. It is of practical importance to know that in such patients with a family history of cancer in the same organ cancer develops at a much earlier age. This means that if for instance a young woman with a history of familial breast cancer presents herself with symptoms suggestive of a breast tumor one can no longer accept the probability mentioned earlier that the tumor is benign and not malignant but one has to consider a graver prognosis and press for an immediate operation. Breast and uterine cancer have so far shown the highest degree of familial incidence. Reliable figures for cancer of the prostate are not yet available. Cancer of the stomach also shows a noticeable degree of a familial incidence while for the skin exposure to extrinsic carcinogenic agents determines the development of cancer to such an extent that no significant familial incidence is observed.

ANIMAL EXPERIMENTATION

Limitations of space forbid the discussion of other examples illustrating the advances made in our knowledge of cancer in man. In looking back over the progress made in the attack on the cancer problem during the past 30 years it becomes evident how intimately observations on human cancer have interacted with the *experimental work on animals*. That our knowledge of human cancer has stimulated experimental work goes without saying—and so often has our lack of knowledge. Conversely the results of experimental work on animal have made it possible on the one hand to reveal new and unexpected relationships between certain features of the human disease and on the other to break up the immense mass of material available from clinical observations on human cancer into smaller groups which have certain features in common. No less impressive is the fact that many agents known to produce cancer in man are capable of inducing cancer in animals and that cancer in all species including man presents the same fundamental features whether it occurs spontaneously or is induced experimentally. It is no exaggeration to say that in no disease of other than bacterial origin does the experimentally produced disease simulate so closely the spontaneous disease as it does in cancer.

COMMENT

One can no longer justify the pessimism which not so very long ago dominated the medical outlook and induced leading authorities on

cancer to proclaim the disease a mystery which the human mind will never solve. A killing disease which is curable and preventable can not well be described as a mystery or as an insoluble problem. That this pessimism has not yet disappeared is regrettable because it is a serious obstacle to further progress. What we know about cancer is only a beginning and much has yet to be learned. It has been the object of this paper to show that the careful collection of large numbers of careful clinical observations on man and their correct statistical interpretation in the light of the knowledge gained by the experimental investigation of cancer in animals fulfil an essential function in this task.

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THE SURGICAL CLINICS of NORTH AMERICA

PHILADELPHIA NUMBER

SYMPOSIUM ON RECENT ADVANCES IN SURGERY

INTRODUCTION

Most of the original work reported in the papers comprising the Philadelphia number of the Surgical Clinics of North America has been done during the war years. The increased need for certain types of medical care has greatly stimulated research and important gains have been made. The federal government has sponsored much valuable work through the Committee on Medical Research of the Office of Scientific Research and Development.

The principal emphasis of necessity has been on methods of therapy and this is reflected in the fact that most of the papers in this volume present practical forms of treatment. In most instances the methods described have already had a sufficiently extensive trial to establish their value. Further clinical experience however should serve to define the limits of usefulness of such methods. In other instances methods are proposed which, after rather limited clinical trial have shown promise in the hope that clinical experience with them may be accumulated more rapidly than would be possible if trial were restricted to one or to a few institutions.

Thus it is hoped that the work presented here may stimulate additional work which will further extend our knowledge of surgical therapy.

In addition to papers by a number of Philadelphia physicians it has been possible to present a very valuable group of papers by members of the medical services of the Army and Navy who have had the opportunity to study various aspects of military surgery and who have had an unusually extensive experience in handling certain problems in traumatic surgery.

JONATHAN E. RHODES

THE SURGICAL ASPECTS OF PEPTIC ULCER

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DESPITE the fact that little is known about the etiology of peptic ulcer great advances have been made in the treatment of the condition. This is due to more precise methods of diagnosis and to collaboration between the physician and the surgeon. Whereas twenty years ago approximately 40 per cent of peptic ulcers came to surgery today the number is nearer 15 to 20 per cent. It is to these phases of the subject that we will direct our attention in analyzing a series of 100 consecutive ulcer patients treated surgically by us during the past four years.

DIAGNOSIS

Indigestion is the commonest complaint of patients presenting themselves to the physician for relief. According to T. Grier Miller¹ peptic ulcer is responsible for the symptoms in 27 per cent of these cases. Examination of hospital records shows that prior to 1920 these ulcers were frequently diagnosed on a functional basis. Diagnoses such as gastric neurosis, gastralgia, hyperacidity and hyperchlorhydria were recorded. It was only after the complications of hemorrhage, perforation or obstruction appeared that the true nature of the original complaint was recognized. Today the diagnosis is made earlier in the disease by the intelligent use of history and physical findings with the aid of the gastroscope, the roentgenogram and laboratory data. When history and laboratory findings do not agree both should be repeated. The proper history is rarely deceiving, the gastroscope is rarely wrong and the interpretation of the roentgenogram is usually correct. Re-evaluation of all data will reduce the number of incorrect diagnoses.

Once the diagnosis is established treatment is a medical problem. Only certain definite complications demand intervention by the surgeon. The surgical indications are (1) perforation, acute or chronic; (2) obstruction; (3) hemorrhage; (4) intractability; and (5) acute or suspected malignancy in gastric ulcer.

PERFORATION

About 10 per cent of peptic ulcers perforate. There seems to be no adequate way of prognosticating when this will happen. Fifteen per cent will occur in patients without a previous history of indigestion.

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or ulcer Another 56 per cent will be in patients who have been and are under medical treatment for known ulcer when the accident occurs Occasionally warnings of an impending perforation are present Such a warning would be a change from the usual ulcer pain to a *constant, sharp, sticking pain* referred to the anterior abdominal wall the shoulder or the back according to the location of the ulcer This change in symptoms usually means penetration deep enough to irritate the peritoneal surface lying adjacent to the abdominal wall the gallbladder pancreas or liver When the symptoms change the pathological picture has changed Patients should be warned of the significance of these changes Contamination of the free peritoneal cavity by a perforation is characterized by the sudden appearance of a severe *stabbing pain in the upper abdomen boardlike rigidity and a frozen attitude*, the victim fearing to move because of the increased pain This picture is modified if the perforation is walled off or occurs into the lesser peritoneal cavity

Roentgen evidence of free air under the domes of the diaphragm is pathognomonic of a ruptured hollow viscus This is an important diagnostic adjunct especially in the doubtful or atypical case In the presence of a typical clinical picture of perforation long delay incident to obtaining confirmatory roentgen studies is not justifiable since operation is indicated with or without the confirmation

Operative Procedure—Simple closure of the perforation with omental reinforcement gives the best results Gastrojejunostomy has not been found necessary in any case of simple perforation in our experience These patients are usually explored through a small upper right rectus incision The longer the period between perforation and operation the higher the mortality figures each additional hour delay increases the mortality until it reaches 70 per cent after 48 hours Perforation with a full stomach increases the amount and degree of peritoneal contamination We have not been impressed with the objections to *drainage* of the contaminated peritoneal cavity The only patient in this series closed without drainage developed a subhepatic abscess This was the only case in which this complication developed Over 60 per cent of the deaths in ruptured ulcer cases are due to peritonitis We therefore routinely use a Penrose drain in the right subhepatic area and right gutter and bring it out through a stab wound in the right flank As much free fluid and gastric contents as possible are aspirated Occasionally the pelvis is drained through a second stab wound above the symphysis There is no proof available that drainage is responsible for the increased mortality published by the advocates of closure without drainage In this series there were no complications that could in any way be attributed to the use of drainage material

Chemotherapy—Systemic chemotherapy is recommended Sulfonamides used locally in the peritoneal cavity are of questionable value In five large clinics positive cultures were obtained from the peritoneal

cavity in 50 per cent of cases under ten hours duration and in 80 per cent over twelve hours. One should bear in mind that although the original peritonitis is chemical in nature the contaminating material must contain organisms in many cases since the incidence of positive cultures increases with time alone as the variable factor.

Mortality—Following the above tenets of early operation closure of the perforation with drainage chemotherapy and suction drainage of the stomach during the first forty-eight to seventy-two hours we have had no deaths since 1935 in ulcer perforations closed within twenty-four hours. In the last seventeen cases there were two fatalities both in neglected cases. One patient operated upon five days after a perforation died of military tuberculosis one week after operation a second patient was operated upon several months after a perforation of a duodenal ulcer. A large abscess was drained and a gastric resection was carried out in an attempt to close the duodenal fistula. The patient died of the effects of a duodenal fistula when the closure in the diseased duodenal stump failed to hold.

The closure of a perforation has a definite curative effect on a certain percentage of these patients. Estes² reports a series of eighty perforations. Only 5.6 per cent of these followed were completely cured 71.7 per cent required medical treatment for control of symptoms and 22.8 per cent required further surgery or hospitalization for relief. He therefore concludes that perforation rarely confers immunity from further ulcer symptoms. Following operation perforation cases require the same continuous medical supervision that any peptic ulcer case requires.

In the seventeen cases in this series followed for periods of four months to four years from the time of operation about 50 per cent were well and free of symptoms at the time of their last follow-up. Two cases were reoperated within three years—one had reruptured and the other had intractable symptoms. In reviewing the patients whom we have operated upon for intractable symptoms in the period 1939-43 it was significant to note that over 10 per cent of them had previously had ruptured ulcers oversewn.

OBSTRUCTION

This complication occurs as a result of scar contracture or edema about an ulcer near the pylorus. Often the patient will give a typical history of ulcer years before with apparent recovery. The obstructive picture may then begin after a long latent period. Postprandial fullness and belching followed by nausea and the vomiting of retention gradually appear to herald the presence of pyloric obstruction and delayed emptying. As the process approaches a complete obstruction, weight loss and roentgen evidence of practically complete retention becomes apparent. In this stage a malignant lesion in the pyloric region is often suspected. In our series of 100 operative ulcer cases obstruction was the sole indication for surgery in 17 per cent. In an additional fourteen

cases obstruction was present in addition to other indications for surgery

These patients require operation. The obstructed stomach must however be prepared for surgery by decompression drainage for several days, correction of fluid and electrolyte balance and attempts at correcting the malnutrition that almost inevitably exists. Frequently gastric lavage and decompression will permit the stomach to empty itself partially after a few days; this is probably due to subsidence of associated edema.

Operative Procedure—With a clean empty stomach and a Levin tube in place the abdomen is explored through an upper midline incision. The operative procedure chosen depends on several factors. If per chance a simple duodenal cicatrix exists without hyperacidity, an antecolic posterior gastrojejunostomy will suffice. This is accomplished by opening the anterior leaf of the gastrocolic omentum and placing the anastomosis on the posterior gastric wall parallel to and about an inch above the greater curvature. We are of the opinion that this permits the suture line to drop posteriorly thus preventing adhesions to the anterior abdominal wall. Moreover the long jejunal loop in front of the colon minimizes the possibility of a gastrojejunocolic fistula and permits easy access to the anastomosis if further surgery is necessary at a later date. If the obstructing lesion is gastric, if the patient's gastric acidity figures are high, if the ulcer is acute or if there are other indications for surgery in addition to obstruction, a gastric resection is the procedure of choice.

In our recent series of seventeen primarily obstructed patients eleven had a gastrojejunostomy performed and six had a gastric resection with no deaths. All but four of these were followed. All were symptom free four months to three and one third years after operation.

HEMORRHAGE

In the presence of a bleeding ulcer the finest teamwork of physician and surgeon is necessary to obtain the best results. Demonstrable bleeding occurs in about one third of peptic ulcers. Hemorrhage occurs under such a variety of circumstances that it is difficult to formulate a set of rules to govern its treatment.

Mortality—Certain factors influence the mortality in a given instance. Old indurated calloused ulcers are dangerous. Acute ulcers which bleed carry little danger. The hemorrhage which occurs in the youngster is more apt to stop spontaneously. In the patient past fifty years of age hemorrhage is more of a threat because sclerotic vessels do not tend to contract. Massive hemorrhages are most often from duodenal ulcers in contrast to gastric ulcers. Such ulcers are usually on the posterior wall of the duodenum with bleeding coming from the pancreaticoduodenal artery or one of its branches.

The high mortality attributed to the surgical treatment of bleeding

ulcers has been the result of operating upon desperately ill exsanguinated patients who have failed to respond to medical management. Inasmuch as it is known today that medical treatment alone carries with it a mortality of only 5 to 10 per cent the only objective of surgical intervention is to salvage some of that 5 to 10 per cent. It has been amply demonstrated that one cannot wait until it is apparent that the patient will die under medical treatment before resorting to surgery. The morality of patients operated upon in a last desperate effort to save a life approaches 100 per cent.

All efforts should therefore be directed toward determining early whether a patient will stop bleeding under medical treatment. The effects of repeated episodes of shock over a prolonged period are often irreversible and may produce death.

Allen^{3, 4} states that about 40 per cent of patients who have had an exsanguinating hemorrhage will not respond to medical treatment and that after two such hemorrhages medical treatment fails in 83 per cent of the cases. His tendency is to operate upon such patients early. It is important first to get the patient over the effects of the hemorrhage even if surgery is planned later.

Fluoroscopic Examination—When one cannot be certain of the source of the bleeding it is best if possible to establish the site of the ulceration before attempting surgical intervention. It is recommended in such cases that a fluoroscopic examination with barium be done during the active bleeding. If there is no danger from a feeding regime in bleeding ulcer the ingestion of barium should be safe if palpation is restricted over the suspected area.

Operative Procedure—If medical measures fail after a reasonable time surgery must be undertaken. Adequate blood is necessary before and during the procedure. The bleeding must be controlled. Since it usually arises from a posterior wall lesion removal of the ulcer bearing portion of the duodenum plus a reasonable gastric resection is the procedure of choice. These patients do not die on the table and will do well if they have not been punished too long by the tissue anoxia of a low blood pressure.

In our recent series of 100 consecutive ulcer cases 28 per cent were operated upon with bleeding as one of or the only indication for operation. Two of these patients were operated upon during acute severe hemorrhage which had failed to respond to medical treatment. Twelve patients had one or more severe hemorrhages prior to an elective operative procedure. The remainder had repeated small bleeding episodes. The results following gastric resection with removal of the ulcer have been uniformly good. Simple gastrojejunostomy was performed in two instances with one poor result. Local ulcer excision without resection was performed in five cases with poor results in three cases. There were no deaths in this group of cases operated upon because of hemorrhage.

INTRACTABILITY

When under adequate medical treatment ulcer symptoms are not controlled surgery is indicated. This type of patient usually has *hyperacidity*. With the passing of time more and more patients who previously had pyloroplasties and gastrojejunostomies as the treatment for their ulcers are returning with recurrent or continued trouble. The results of such procedures as these have not proved entirely satisfactory. Today a partial resection of the stomach appears to be the most successful measure for the treatment of the intractable ulcer.

Operative Procedure—The most popular resection today includes removal of the pylorus and ulcer bearing portion of the duodenum and a subtotal gastrectomy with a Balfour or Hofmeister end to side gastrojejunostomy. Two immediate hazards of this procedure are a blowout of the duodenal stump or a poorly functioning stoma. To prevent the former complication we crush the duodenal stump with a Payr clamp and oversew with a continuous chromic catgut suture through the normal tissue at the base of the crush. This in turn is buried with two layers of interrupted Lembert sutures of the same material and is then buried against the pancreas. The suture line is further reinforced with a tab of gastrohepatic omentum. Such a stump should never be closed above an obstructing lesion.

To facilitate the anastomosis we use a Bartlett Eastman clamp. A long loop of jejunum 10 to 12 inches below the ligament of Treitz is brought in front of the colon and approximated to the end of the stomach with the proximal loop at the lesser curvature and the distal loop at the greater curvature. This simple arrangement of the loops has in our experience eliminated postoperative vomiting by permitting better emptying of the proximal jejunum.

This procedure however cannot always be carried out. At times the ulcer may be so adherent to the pancreas and surrounded by edema and inflammatory reaction that removal of the ulcer bearing portion of the duodenum would be foolhardy and dangerous. Under such circumstances we have employed the Devine exclusion procedure which divides the stomach about $1\frac{1}{2}$ inches proximal to the pylorus closing the stump in the same fashion as outlined for the duodenum. In a number of recent cases we have removed the gastric mucous membrane from the stump down to the pylorus before closing the other coats of the cuff.

Intractable gastric ulcers should be subjected to surgery early because of the possibility of malignancy. Should a gastric ulcer not respond to medical treatment in three or four weeks surgery should be employed and a pylorectomy and gastrectomy performed.

Heuer and Holman⁵ recently studied 163 patients subjected to gastro-enterostomy or gastric resection for peptic ulcer. In the gastrojejunostomy group there was no significant change in gastric acidity.

yet 75 per cent of these patients were clinical cures. With resection there was a general reduction in acid in proportion to the extent of the resection. In the authors' opinion, resection consistent with reasonable mortality does not insure achlorhydria. Furthermore, even in maximal resections 90 per cent of the patients had satisfactory results, although only 25 per cent had a reduction in acid. They conclude that it is of doubtful value to remove more and more of the stomach looking toward achlorhydria. It is probably better to accept the safe limitations of resection consistent with satisfactory results and a reasonable mortality.

Hunt⁶ believes that achlorhydria should not be the goal of surgery in peptic ulcer. He feels that a resection to include half the stomach is sufficient in the average case, with more liberal resections reserved for patients with excessively high acid figures. No surgical procedure now in use for peptic ulcer will guarantee against a recurrence in all cases. We should strive therefore to remove the ulcer and reduce the acid factor.

Postoperative Results.—In our recent series of 100 ulcer cases, 69 per cent had symptoms intractable to medical treatment as one of the indications or the only indication for surgical intervention. There were no deaths. Once again gastric resection with removal of the ulcers gave uniformly good results over follow-up periods of from four months to five years after operation. With the Devine type of gastric resection, in which the ulcer-bearing portion of the duodenum was not removed for technical reasons, the results were excellent in all but four of twenty-nine patients. Two of these patients still have ulcer symptoms; a third developed an anterior wall perforation in the blind duodenal loop nine months after the original procedure; the last developed a marginal ulcer.

Of eight patients who had a simple gastrojejunostomy performed for intractable ulcer, three have had recurrent difficulty and must be classed as poor results.

Finally, of three patients treated by simple local excision of intractable ulcers, two have been complete failures. One of these had a wedge resection of a gastric ulcer and later had to have a subtotal gastrectomy for recurrent ulcer. The second patient has had a similar experience but has as yet not been subjected to further surgery.

SUMMARY

A consecutive series of 100 cases of peptic ulcer operated upon in Service C at the Hospital of the University of Pennsylvania is reported with a mortality of 2 per cent. The indications for operation were perforation in 17 per cent, obstruction in 17 per cent, severe hemorrhage in 28 per cent, and intractability based on repeated recurrences of pain 55 per cent—which reads 69 per cent if we include some of

those cases of recurring hemorrhages. No attempt has been made in this study to evaluate the permanent or five-year cures. It is hoped that a future study of earlier cases will present this important analysis.

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PENICILLIN IN SURGERY

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With the discovery of each new chemotherapeutic agent it becomes necessary to revise the treatment and management of those diseases which respond to its administration. The specific agent must be added to therapy in appropriate dosage and administered by the proper route. This necessitates a knowledge of its effects, limitations and toxicity. Furthermore, one should eliminate those supportive measures which are nullified by the use of specific therapy, add those required for optimal results with the new agent, and continue those other features of management which hasten recovery and cure. The succession of sulfonamides, each an improvement upon the last, has brought about a tremendous increase in our understanding and improvement in the therapy of surgical infections. With the introduction of penicillin we have an agent more powerful than the sulfonamides, with a wider range of effectiveness and much lower toxicity. Although this new drug has extended the field of specific chemotherapy, its administration remains difficult and requires constant attention if optimal results are to be obtained. Moreover, there are certain bacteria upon which it has no effect.

In the treatment of any disease, diagnosis is of primary importance. In surgical infections, diagnosis should include the portal of entry, the extent of involvement, the part or parts affected by the disease, and the etiologic organism or organisms. This latter feature of the diagnosis requires complete aerobic and anaerobic bacteriologic studies of the local lesions, if accessible, and of the blood, if indicated. Fortunately, most of the pathogenic bacteria which produce surgical infection are sensitive to penicillin. It is therefore justifiable in acutely ill or moribund patients to institute penicillin therapy as soon as the clinical diagnosis of suppurative infection is confirmed and cultures have been taken, without waiting for the reports of the cultures.

METHODS OF ADMINISTRATION

Penicillin given by mouth is destroyed by the free hydrochloric acid present in the stomach. Instillation of the drug into the duodenum by way of a tube results in incomplete and inconstant absorption of the material. If administered by rectum, penicillin is rapidly destroyed by penicillinase, which is elaborated by bacteria normally present in the rectum. To date, only parenteral and local routes of administration

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have been proved successful and they should be employed if the drug is to be effective. Penicillin is rapidly eliminated from the body principally by way of the urine. It is therefore necessary to administer it either continuously or at frequent intervals.

Intravenous Therapy—The most rapidly effective method of administering penicillin is by continuous infusion of dilute solutions of the drug in suitable amounts of physiological saline solution and 5 per cent glucose solution. If the acuteness or severity of the infection warrants this method of therapy the drug should be given continuously day and night until the infection has been controlled. Although continuous infusions of penicillin have been associated with a frequent occurrence of venous thrombosis the evidence that this undesirable reaction is due to penicillin is inconclusive. It appears more probable that the type of diluent and the technic of administration are responsible. Herrell¹ suggests that glucose solutions even in low concentrations may be irritating to the intima of the veins; however it is inadvisable to use only saline solutions because of disturbances in electrolyte equilibrium. It is therefore desirable to use isotonic solutions of 5 per cent glucose in distilled water alternately with appropriate amounts of physiological saline solutions.

In regard to technic several points seem worthy of mention. A single venipuncture should not be utilized for more than one day's treatment. While it is often possible to use one vein for two or even several days the safest plan is to change the location of the needle daily and preferably to another extremity. It is wise to use freshly sterilized apparatus for each new venipuncture. The volume and type of fluid should be adjusted to the tolerance and requirements of the individual patient. Most individuals over fourteen or fifteen years of age can easily tolerate 3000 cc. of intravenous fluid daily. This permits the addition of one third the daily dose of penicillin to each liter of fluid; thus 1000 cc. of solution should drip over a period of eight hours at about 35 drops per minute.² If intravenous therapy is indicated and venipuncture seems impossible cannulation of a vein or bone marrow infusion may be used.

While intermittent or multiple intravenous injections of penicillin may be suitable for some types of short term therapy they are unlikely to be satisfactory in the treatment of surgical infections which require more prolonged treatment.

Intramuscular Therapy—The most commonly used route of systemic administration of penicillin is by frequent intramuscular injections. The interval between injections should not exceed four hours. Injections every two hours day and night are probably optimal. The daily dose should be equally divided between the number of injections and the site of administration rotated between well developed muscles of muscle to prevent continued local trauma. For intramuscular therapy the total daily dose of the drug should be dissolved in a convenient volume of

saline or distilled water and should be sufficiently concentrated to avoid discomfort on the basis of volume. Two to 4 cc. is a suitable amount for each injection. After the drug is in solution it should be ordered in terms of cubic centimeters and not in units. Fresh solutions should be prepared daily and kept in a refrigerator on the ward or floor. The use of 20 to 22 gauge needles long enough to reach well into the muscle mass on syringes sterilized by autoclaving or boiling has been most satisfactory. If injections are painful it may be necessary to dissolve the penicillin in a 0.5 or 1 per cent procaine solution. While this does not interfere with the effectiveness of the drug it should be used with extreme caution to avoid accidental intravenous injection. These solutions should always be labeled "Not for Intravenous Use."

Subcutaneous Therapy—Penicillin solutions injected subcutaneously are absorbed slowly and may be painful. One group of investigators, however, has used continuous hypodermoclysis in patients who required continuous therapy but could not tolerate a continuous intravenous infusion.³

Local and Topical Therapy—Systemically administered penicillin does not always enter infected cavities in sufficient concentrations to be effective. Therefore it is frequently necessary to augment the systemic therapy with local instillations. In infections which are easily accessible penicillin may be applied topically in dilute solutions containing 250 to 500 units per cubic centimeter. The dry powder of penicillin is irritating and may be quite painful on a raw surface. However, Florey and his associates⁴ have used the dry material mixed with powdered sulfanilamide or sulfathiazole in concentrations of 500 to 5000 units per gram. They have also used ointment preparations with some success.

DOSAGE

The apparent lack of toxicity of penicillin makes dosage arbitrary at present. As supplies increase and cost decreases doses considerably larger than those now considered therapeutically effective will probably be used. The range of dosage and the preferred routes of administration will be discussed under the specific types of surgical infections considered below. The dosage for children is often lower but should seldom be less than 50,000 units a day if systemic treatment is indicated.

PROPHYLAXIS

There are many possibilities of penicillin prophylaxis yet untested. At the present time, however, it is known that penicillin is of value in the prevention of postoperative infectious complications following lung resection.⁵ Isolated experiences indicate that it may be of value in the prevention of infection in contaminated wounds.⁶ It appears to be helpful in the control of infection in chronic osteomyelitis pre and postoperatively.⁶

DURATION OF TREATMENT

Our present practice is guided by the following rules. Penicillin therapy should be instituted as soon as the diagnosis of a susceptible type of infection has been established. Treatment should be given in full dosage from the earliest possible time until the infection has completely subsided. Thereafter a tapering off procedure may be followed. For any severe acute infection therapy should be continued until at least a week after the temperature reaches normal while in less severe infections a shorter period may be sufficient although three days should be a minimum. Where infection is highly localized and the temperature graph is of little significance the duration of therapy should be adjusted to the clinical and bacteriological response of the lesion. The local treatment of empyema should be continued for at least ten days with daily thoracentesis and instillation of the drug. Caution should be employed in discontinuing therapy for acute suppurative secondary meningitis since early termination often results in a recrudescence of the infection.

RESPONSES TO PENICILLIN THERAPY

The Typical Response—The response of very ill patients is usually less dramatic than the crisis so often seen in pneumonia after the administrations of sulfonamides. For instance in patients with severe acute infections such as acute osteomyelitis, extensive carbuncles, hemolytic streptococcal bacteremia or pneumococcal meningitis with admission temperatures of 103° F or over who appear toxic, dehydrated and anemic, full doses of penicillin tend to produce the following chain of events. First there is increasing mental clarity and loss of the appearance of toxicity. This frequently occurs within twenty-four hours. Local pain when present often subsides by the end of forty-eight hours and by the fourth day the temperature will have dropped possibly two degrees. By the end of a week the patient will feel quite comfortable, the leukocyte count may have returned to the normal range and the hemoglobin level will be likely to have improved. The temperature may not flatten out at 98.6° F for a full week. Thereafter the patient will gain in strength and appetite and have a rather rapid convalescence.

Failure of Response—If the early subjective and subsequent objective improvement does not appear, the preparation and administration of the drug should be checked and the sensitivity of the organism to the drug should be determined. The dosage may need to be increased or a change made to another chemotherapeutic agent. A renewed search should be made for concomitant disease and for areas of necrosis or suppuration requiring external drainage.

SUPPORTIVE CARE

It is essential that good surgical principles be observed and that the entire burden of therapy does not rest on the chemotherapeutic agent. Penicillin is only capable of inhibiting certain bacteria. Apparently it has no other powers. Acutely ill patients and even those with less severe infections should receive adequate supportive care such as bed rest, adequate fluids, maintenance of electrolyte equilibrium, adequate diet, plasma or blood transfusions if indicated, and surgical drainage of pointing purulent areas. This by no means completes the list but only suggests some of the more important features of good management. Penicillin is supplementary to, not a substitute for, surgical care.

TOXICITY

Adverse reactions to penicillin are infrequent and seldom serious. Occasional chills and fevers are still encountered with the intravenous administration of the drug.⁶⁻⁷ Intravenous solutions of penicillin sometimes become contaminated with mold or gram-negative bacilli. An urticarial reaction occurs rather infrequently. This reaction may produce discomfort but it is seldom of any importance for the rash will usually disappear even though therapy is continued.⁶⁻⁷ Occasionally the itching may be so severe as to necessitate cessation of therapy. Palliative management of the urticaria is usually sufficient. On occasions transient neutopenia has been noted in conjunction with penicillin therapy.⁶⁻⁸

PENICILLIN IN ACUTE INFECTIONS

Staphylococcal Bacteremia—The mortality in staphylococcal bacteremia was reduced from about 85 per cent to 70 per cent with the use of the sulfonamides. The mortality in cases treated with penicillin has varied from 14.3 per cent to 37.0 per cent.¹⁻⁷ The greater specificity of penicillin demands its use in any staphylococcal bacteremia. Doses of from 100,000 to 200,000 units per day are usually sufficient. The preferred route of administration is by continuous intravenous infusion until the infection is under control. Subsequently, intramuscular therapy may be used until all active infection has disappeared. Local collections of pus should be evacuated if frankly fluctuant and accessible. Drainage of deep-seated lesions may be delayed until the effect of the drug alone can be determined and the patient prepared for surgery. The use of the drug will often make surgical intervention unnecessary. Acute osteomyelitis may well be treated for a trial period with penicillin before operation is carried out unless a frankly fluctuant pointing area requires drainage.

Beta-Hemolytic Streptococcal Bacteremia—The incidence and mortality from this disease has been sharply reduced with the use of sulfonamides. Penicillin is somewhat more potent against these organisms.

than the sulfonamides and should certainly have preference in acutely ill patients.⁷ Since the two drugs are compatible there may be good reason to combine the therapy in these infections. A daily dose of 80 000 to 150 000 units of penicillin is usually sufficient. The preferred route of administration as in staphylococcal bacteremia is by continuous intravenous drip until the acute phase of the disease has subsided when it is then justifiable to resort to intramuscular therapy.

Cavernous Sinus Thrombosis—This disease is usually associated with bacteremia and should be treated in the same manner. Anticoagulants such as heparin or dicoumarin may be useful as adjuvants.⁹

Pneumonia—While pneumonia cannot be considered a surgical disease it is included in this discussion because it is a frequent complication in surgical patients. In most instances sulfonamides provide adequate therapy but the use of the more potent penicillin may be indicated in grave situations. The daily intravenous or intramuscular administration of 80 000 to 150 000 units of penicillin is the usual dose.⁷

Atelectasis—Surgical patients who develop acute atelectasis should receive either sulfonamides or penicillin. In patients running high fevers doses of 80 000 to 150 000 units of penicillin should be given systematically each day.

Acute Lung Abscess—The presence of an acute pulmonary abscess or abscesses is an indication for penicillin therapy. Daily doses of from 100 000 to 200 000 units by intramuscular administration are usually adequate. Some cases may require continuous intravenous infusions of the drug. Bronchoscopic drainage if feasible is indicated as supportive treatment.¹⁰

Acute Suppurative Pericarditis—This infection occurs infrequently but it is most often produced by organisms which are inhibited by penicillin. Full systemic therapy of from 100 000 to 200 000 units daily by intravenous or intramuscular administration is indicated. In conjunction with the general therapy 20 000 to 40 000 additional units of the drug should be instilled locally each day after aspiration of the pericardial sac. Therapy should continue for at least two weeks and preferably for three.

Peritonitis—If peritonitis is seen within the first few hours of its development or if there is heavy contamination of the peritoneal cavity as a result of traumatic violence or an operative procedure the immediate institution of penicillin therapy by the continuous intravenous route seems indicated. However if infection has become established as a result of fecal contamination penicillin may be of considerably less value than the sulfonamides.¹⁰ The reason for this is the presence of *Escherichia coli* and other organisms commonly found in the intestinal tract which elaborate a substance known as penicillinase which is capable of rendering penicillin completely ineffective. Thus if penicillin is given before these organisms have become established it may be of value in preventing or controlling the development of the invasive

or necrotizing infections commonly produced by gram positive cocci. However the drug has been found to be ineffective against many strains of enterococci and especially those which grow anaerobically.³ Penicillin has not yet been fully evaluated in peritonitis.

Urinary Tract Infections—The infections of the urinary tract are most frequently caused by gram negative bacilli which are unaffected by penicillin. However recent reports of the sensitivity of some strains of *Proteus vulgaris* to penicillin may indicate its use in selected cases infected with these organisms.²¹ Gonorrhea usually responds rapidly to penicillin in minimal doses.⁷ Cases of pyelitis or cystitis caused by streptococci or staphylococci should first receive sulfonamid therapy. If this is not successful penicillin may be useful. Experience is limited but daily doses of from 80 000 to 150 000 units by intramuscular injection seem adequate. The excretion of penicillin in the urine in therapeutically effective concentrations contributes to the success of this form of therapy.

Empyema—Penicillin has been successfully employed in the treatment of pneumococcal and staphylococcal empyema. Although there has not been sufficient experience with penicillin in the treatment of streptococcal empyema to give definite evidence of its effectiveness it appears to be useful in those cases treated. If pneumococcal empyema is acute and follows pneumonia systemic therapy is indicated to aid in controlling the pneumonia. If the empyema is well walled off and the pulmonary phase of the disease has subsided local instillation of from 20 000 to 40 000 units each day have sometimes been sufficient without systemic therapy. In any event patients with empyema should receive daily aspiration of all purulent material obtainable followed by the instillation of a concentrated solution of penicillin. This should be continued until there is marked regression of the infected cavity by x ray examination.

Secondary Suppurative Meningitis—Patients with meningitis caused by pneumococci streptococci or staphylococci should receive from 80 000 to 200 000 units of penicillin daily by continuous intravenous infusion during the acute phase of the disease. Later intrathecal therapy may be used. All patients with these infections should be given daily intrathecal injections of from 10 000 to 20 000 units of penicillin which may be made intraspinally intracisternally or directly into the lateral ventricles through burr holes in the parietal bones.¹

Acute Suppurative Arthritis—Acute purulent arthritis is usually caused by organisms sensitive to penicillin. These infections often respond to frequent aspirations of joint collections followed by the instillations of 5000 to 10 000 units of penicillin.⁷

Carbuncles and Furuncles—For the treatment of these localized lesions systemic administration of from 80 000 to 150 000 units of penicillin daily usually results in rapid control of subsidence of infection. Flaccuant areas of pus that can be aspirated may be followed by local

instillations of from 5000 to 10 000 units of the drug into the infected space. Incision and drainage can sometimes be avoided if these infections are treated thoroughly with penicillin.

Cellulitis Lymphangitis and Lymphadenitis—These diffuse and metastatic infections are usually attributed to streptococci though other organisms may be involved. While sulfonamides are commonly employed with success in these infections penicillin is equally effective and may act more promptly. Systemic therapy of from 80 000 to 150 000 units daily is indicated. Cellulitis of the face is most frequently caused by staphylococci or streptococci. Because of the danger of the spread of these infections they should receive systemic penicillin therapy by the continuous intravenous route until completely controlled.¹⁰

Suppurative Wound Infections—Penicillin is being used extensively in military surgery with considerable success. British investigators working with Florey have demonstrated the tremendous value of the material both as a topical agent in wounds and as a therapeutically effective systemic agent in the control of extensive infection. For spreading or massive infections from 100 000 to 300 000 units of the drug by systemic administration should be used, adjusting the dosage to the requirements of the patient. Local therapy may be administered as dilute solutions of penicillin instilled through tubes or incorporated in wet packs. Several powders and ointments have been tried with varied results.⁴

Infected Burns—These infections may be regarded as superficial wounds and treated in a similar manner. Local therapy is sometimes sufficient.

Clostridial Infections—Infections produced by clostridia should logically be included under wound infections but the particular problem of management that these lesions present justifies separate considerations. *In vitro* studies indicate that penicillin is effective in inhibiting these organisms but the infrequency of infections produced by these anaerobic bacteria makes it difficult to accumulate evidence as to the clinical value of the drug. The organisms abound in the necrotic tissue of heavily contaminated traumatic wounds and are frequently present without producing evidence of infection. When gas gangrene, tetanus or malignant edema develops the clinical picture is striking. The extensive necrosis which results from some of these infections make it questionable if any systemically administered drug will reach the organism via the blood stream in sufficient concentrations to be effective. Surgical debridement therefore remains an essential feature of treatment. Penicillin will not alter the free toxin elaborated by the organisms thus continuing the necessity for adequate amounts of specific antitoxin. Penicillin at best will only inhibit the bacteria and thus decrease or prevent the further production of toxins. Therapy should probably be heroic with the administration of from 100 000 to

400 000 units of the drug each day by the continuous intravenous route⁶

PENICILLIN IN CHRONIC INFECTIONS

Osteomyelitis—The place of penicillin therapy in the treatment of chronic osteomyelitis remains to be established. Evidence indicates that it will be most useful in controlling infection and permitting surgical excision of necrotic and chemically infected tissue with a minimal amount of local and systemic reaction. There is little possibility that the drug alone will result in cure in more than isolated cases which exhibit chronic suppuration. While there may be temporary decrease in suppuration with either systemic or local therapy or a combination of the two, the presence of bony sequestra and other dead tissue will make the period of improvement a transitory and disappointing one. In preparation for surgery, daily doses varying from 100 000 to 300 000 units should be used systemically in an attempt to reduce active infection to a minimum and if possible control suppuration.^{6, 10} The drug should be continued postoperatively for at least two weeks. Encouraging results have been achieved in this way.

Bronchiectasis—Penicillin appears to be of value in controlling the infection and suppuration in and about the dilated bronchi.¹⁰ This suggests the value of the drug in the preparation of these patients for lobectomy and pneumonectomy. One group of investigators has used the drug prophylactically with unusual success in patients subjected to lung resections.⁵ Doses of 150 000 units daily given by intramuscular injection have been found effective.

Chronic Lung Abscesses—The dose and route of penicillin administration in multiple lung abscesses are much the same as for bronchiectasis.

Actinomycosis—Bovine actinomycosis is inhibited by penicillin *in vitro* and preliminary clinical trials indicate its usefulness. A daily dose of 100 000 units given by intramuscular injections is sufficient.

Ulcerative Colitis—Patients with ulcerative colitis sometimes show temporary improvement with penicillin, but its value in this condition has not yet been established.

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THE USE OF SPECIALLY PREPARED GELATIN SOLUTION AS A PLASMA SUBSTITUTE

C. I. VETTER, M.D.

Of the several substances which have been intensively studied as plasma substitutes during the present war gelatin seems definitely superior to all save those that are themselves derivatives of human blood and according to recent tests it is at least equal to plasma itself in the treatment of shock due to hemorrhage or burns. Unlike certain other colloidal substances it is remarkably nontoxic and nonantigenic both in the laboratory and in the hospital where it has now been given to over 200 patients.

It should be stressed at the outset that the gelatin solutions used were specially prepared from selected raw materials to finished product in a plant designed especially to prepare gelatin for intravenous administration to patients.

Colloidal solutions such as gelatin are offered not as substitutes for whole blood but rather as substitutes for plasma. Except in the treatment of hemorrhagic shock where the problem of shock with its depression of vital functions is of greater immediate importance than the associated anemia no colloidal solution is intended to replace whole blood.

Plasma is used chiefly for its coagulating function its nutritional value to aid in the defense against infection and for the properties associated with the colloidal osmotic pressure of its proteins. Unless special precautions are observed much of the prothrombin content of plasma is lost in the early period of storage. In addition whole blood is used more extensively than plasma by most clinicians for its anti-hemorrhagic and antibacterial properties. Perhaps the chief use for which plasma is employed is for the colloidal osmotic pressure of the

From the Harrison Department of Surgical Research, School of Medicine, University of Pennsylvania, Philadelphia. Preliminary reports of these studies were presented at four conferences on gelatin which were convened by the Subcommittee on Blood Substitutes of the National Research Council, in Washington, D. C. November 10, 1941; February 23, 1943; September 24, 1943; and March 5, 1944.

Investigation of the role of gelatin as a plasma substitute has been aided by W. M. Parkins, Ph.D., C. Riegel, Ph.D., H. M. Vars, Ph.D., J. S. Lowwood, M.D., A. G. Fletcher, Jr., M.D., and H. R. Ratcliffe, Sc.D. The gelatin used in these studies was supplied through the courtesy of Dr. D. T. Mollot of the Charles B. Knox Gelatine Co., Johnston, N. H.

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plasma proteins where the desired result is maintenance of adequate blood volume and its many related physiological phenomena. It is for this particular purpose that gelatin solutions are used so efficiently.

THE CRITERIA FOR AN IDEAL PLASMA SUBSTITUTE

The ideal plasma substitute should be a material that has certain fundamental physical, physiological and immunological properties. Plasma itself has not been proved to be the ideal colloid by tests of comparative efficacy in spite of its wide use. The criteria for any substitute for plasma are usually more stringent than those applied to the plasma itself.

Physical Properties—An ideal plasma substitute should be stable of low viscosity and high colloidal osmotic pressure. It should have a colloidal particle size sufficiently large to cause it to be retained in the circulation long enough to be effective. Finally, there should be no difficult problems with storage.

Physiological Properties—Such a colloidal solution must be safe for injection in large quantities. It should not interfere with blood coagulation, the defense against infection, or tissue repair. The function of internal organs must not be affected either by frank toxicity or by the storage of the colloidal material in liver or kidney.

Immunological Properties—No intravenous solution should be an antigen and there should be no natural sensitivity with similar substances such as foods or sera.

The ossein gelatin which we have used satisfies, we believe, all of these requirements. Such a statement cannot be made about any other plasma substitute with the possible exception of derivatives of human plasma.

PREPARATION OF GELATIN SOLUTIONS

The gelatin solution which has been most satisfactory is one prepared by hydrolysis of alkali-treated long bone collagen under controlled and standardized conditions. It is administered as a 6 per cent solution in physiological saline solution after autoclaving for twenty minutes.* This solution is preferred for the treatment of shock because its method of preparation produces the optimum molecular size of the gelatin upon which its physiological action largely depends.

When gelatin solutions are subjected to high temperatures such as those required in sterilization by autoclave, the long gelatin aggregate molecule is broken down to form a larger number of smaller molecular particles. Whereas the smaller molecules theoretically exert a higher oncotic pressure, they are excreted from the blood stream through the kidneys so rapidly that their effective oncotic pressure is short-lived and not of the sustained value of the larger molecules which actually exert a lower osmotic pressure.

This is the solution Knox P 20 referred to by the National Research Council in its report on Gelatin as a Plasma Substitute JAMA 125:84, 1944.

For this reason two factors are of importance in the manufacture of gelatin solutions as a plasma substitute the source of the gelatin and the method of preparation of the solutions. Bovine long bones are a better source of gelatin than skins, hides or fish products because of their relative freedom from bacterial and fungus contamination and their uniformity of composition. Solutions prepared from such gelatin require the minimum of heat in the process of manufacture to rid them of bacterial contamination and therefore it is possible to produce an end product with the largest possible gelatin molecule and hence the most sustained effect on oncotic pressure. A twenty minute period of autoclaving for such solutions maintains a sufficiently large molecule while making bacteriological sterility certain.

Gelatin solutions for intravenous use should be prepared for that purpose and apart from the commercial manufacture of edible gelatin. Even the use of pure USP edible gelatin in the preparation of intravenous solutions may result in a pyrogenic product because of impurities that may render it unfit for parenteral use.

There are several advantages in the preparation or processing of gelatin solutions. Whereas the preparation of plasma must be undertaken with the most rigid sterile technic, gelatin solutions if prepared with reasonable cleanliness can be thoroughly sterilized in the last step in manufacture by autoclaving and Seitz filtration. Gelatin solutions need not be refrigerated as fresh plasma must be and they can be kept in a single container as compared with the two need of for lyophilized plasma.

When solution is prepared as a single dose package no preservative need be added. This avoids the possible danger of chemical phlebitis due to preservatives.

The great advantage of gelatin is that it is readily available at relatively low cost and that we are not dependent upon blood donations to obtain it. This is of special practical importance in localities and hospitals where plasma banks are not established.

METHOD OF ADMINISTRATION

Gelatin solutions are miscible with all of the usual intravenous solutions and can be administered by means of any of the open or closed methods. The open system which is frequently used for transfusions of whole blood or plasma has been satisfactory for use with gelatin.

Unless heated, gelatin solutions of the type recommended are in the physical state of a gel at ordinary room temperature in the temperate zone. However, because the gelation point is lower than the melting point, these solutions once warmed remain fluid at room temperature unless exposed to a cold atmosphere such as that from an open window. Gelatin solutions kept in a warm closet at 37° C are ready for immediate use. Inasmuch as there is a very slow degradation, or shortening

ing of aggregate molecular chains such solutions should not be stored at 37° C over a month. An alternate method of preparation is immersion of the gelatin bottle in a hot water bath until melting takes place. Minimal viscosity and hence greater speed of infusion is found at 50° C. The return to the gel state does not occur until ample time has passed for administration at ordinary room temperature.

It might be added here that solutions of the smaller gelatin molecule have a lower gelation point and are liquid at temperatures well below average room temperature. These solutions are somewhat inferior in the treatment of shock and in other clinical states where the larger molecular gelatin is beneficial.

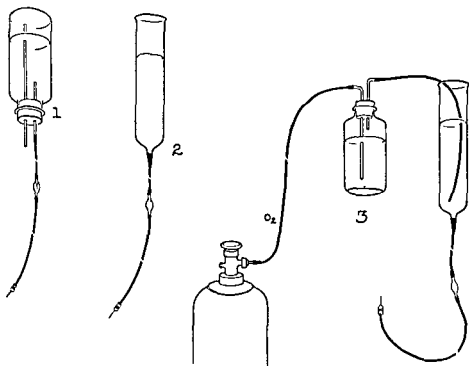


Fig 4) Methods of administering gelatin 1 Closed system 2 open burette 3 erythrocyte gelatin mixture using oxygen jet to prevent sedimentation

As with plasma or whole blood it is advisable not to use needles of a size smaller than 19 gauge for gelatin infusions. In the treatment of shock where it is occasionally of advantage to administer gelatin relatively rapidly, an 18 gauge needle should be used. It has not been necessary in the cases treated by us to infuse gelatin under pressure although there is no reason why such a method would be impractical because of any properties of gelatin.

It is possible to administer a suspension of erythrocytes with gelatin. This is an inexpensive procedure in those places where erythrocyte suspensions are available without cost as a by product in the preparation of plasma. One difficulty arises in the administration of gelatin

crms associated with severe hemorrhage may be overcome in less than fifteen minutes after the start of gelatin infusion when the blood pressure begins to recover.

Effect of Gelatin on the Serum Proteins.—With the marked hemodilution which follows the infusion of gelatin solutions there is a decrease in the concentration of the serum proteins. The concentration of serum protein however after gelatin infusion is less than the anticipated level calculated from hemodilution alone. Careful analysis of the blood for the various serum protein fractions reveals that there is a depression in the concentration of the serum proteins approximately equal to the concentration of the circulating gelatin. The albumin and globulin are proportionately depressed.

As the gelatin concentration in the circulating blood falls there is rise in normal serum proteins which are restored to their normal figures or higher when the gelatin has completely disappeared from the blood. This suggests that control of the labile protein stores for maintenance of serum protein concentration is governed by the intravascular oncotic pressure.

Metabolism of Gelatin.—Most of our knowledge concerning the metabolism of gelatin is based upon indirect evidence. The amount of gelatin excreted in the urine can be accurately determined and inasmuch as there is no evidence of storage in any of the viscera it is assumed that unexcreted gelatin is metabolized.

Gelatin is an incomplete protein lacking four of the essential amino acids. When it is in mixed gelatin has been combined with a mixture of amino acids derived by hydrolysis of casein. Evidence is far from complete but it appears as though the amino acids increased the utilization of gelatin. This is suggested more by the favorable nitrogen balance figures than by marked differences in the amounts of gelatin excreted. Between 50 and 75 per cent of infused gelatin is not recovered from the urine. It has not yet been determined with any degree of accuracy which size gelatin molecule is best utilized for nutritional purposes.

Use of Gelatin in the Study of the Capillaries.—The study of the effects of gelatin through the capillaries has not been completed and only a few observations have been made.

By the determination of the amount of gelatin excreted in the urine after infusion of a known amount it is possible to make some estimate of the permeability of the glomerular capillaries to gelatin. The excretion of the larger molecular gelatin is lower and less complete than that of small molecular gelatin.

The smaller molecular gelatin also leaks into pleural and peritoneal cavities more readily than do the larger particles. In several cases the gelatin concentration of the pleural fluid was determined after gelatin infusion, it is evident that but little of the larger particles leaked out of the capillaries but the smaller molecule were found in a much higher concentration.

SAFETY OF ADMINISTRATION

The administration of single and repeated infusions of ossein gelatin has been accompanied by few local or general reactions. Venous thrombosis has occurred in less than 3 per cent of infusions. This was true even when phenyl mercuric borate was added to the gelatin as a preservative.

No unusual difficulty has been encountered in local extravasation of gelatin solution from its accidental introduction subcutaneous. The use of hot wet dressings is of advantage in hastening the absorption of such collections.

On only one occasion has there been a serious systemic reaction to gelatin and that in a patient who had exhibited anaphylactoid reactions to all of the other intravenous solutions which he had been given including such supposedly innocuous fluids as glucose in water and saline. Minor systemic reactions such as headaches, nausea and vomiting are not encountered as frequently in our experience as they are with blood or plasma. Allergic manifestations have not been seen and in repeated infusions the problem of sensitization has not been encountered.

Extensive investigation of possible toxic effects of intravenous gelatin has failed to reveal any evidence that would suggest alteration in liver or kidney function following single or repeated infusions.^{4 5 6} Not even in patients with known liver or kidney disease has there been any evidence of impairment of function following gelatin infusions as judged by standard clinical tests of liver and kidney function.

There has been no indication of any alteration in normal wound healing, blood coagulability or defense against infection.

THE CLINICAL USE OF GELATIN SOLUTIONS

Treatment of Shock—Experience in treating shock following burns, hemorrhage and trauma has demonstrated gelatin solutions to be effective.

It is difficult in clinical practice to judge the comparative efficacy of a plasma substitute separated as one is from the controlled conditions of the laboratory.

The rapid response to gelatin following severe hemorrhage is well illustrated in a fifty-two-year-old white man who was seen shortly after a profuse hemorrhage from a wound in the femoral vein. His respirations were of the Cheyne-Stokes variety and his pulse was slow; otherwise he presented the typical picture of shock. Death seemed imminent. A 6 per cent gelatin solution was given immediately by two simultaneous infusions. One liter was given in thirty minutes. The patient's response was quite satisfactory. His clinical record and hematocrit readings are graphically illustrated in Figure 457.

Studies on volunteers bled into shocklike states while under observation on the ballistocardiograph has established the efficacy of gelatin in the treatment of hemorrhage on physiological grounds.

The response of one such volunteer illustrated in Figure 458 indicates clearly the changes in the vital processes intimately associated with the clinical syndrome of shock following hemorrhage and the influence of gelatin replacement on these changes. Coincident with the gelatin infusion there was a rise in systolic and diastolic blood pressure followed shortly by a widening of the pulse pressure. The cardiac output which fell rapidly with hemorrhage was restored. The pulse rate which may rise with prolonged slow hemorrhage but which has been shown to fall following experimental hemorrhage⁹ also responded favorably. Hemodilution as measured by the hematocrit readings was sustained during the time of observation and for an additional twenty-four hours.

the treatment of burns but Dr Everett I Evans has treated a comparatively large series of second degree burns with gelatin with success comparable to that obtained with plasma¹⁰ He believes that repeated infusions of 500 cc of gelatin solution every four to six hours is a

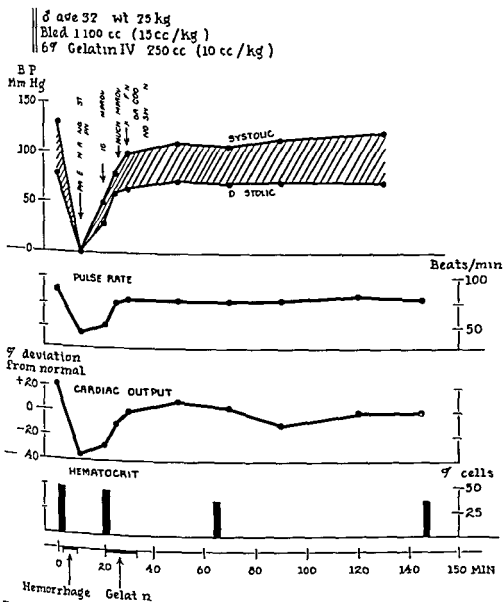


Fig 458—Experimental hemorrhage (15 cc per kilogram) in man with gelatin replacement (10 cc per kilogram)

better practice than less frequent larger infusions and that after thirty six or forty eight hours whole blood is usually indicated

Because of the size and shape of the gelatin molecule it is likely that it is lost less readily from the surface of a burn than is plasma although no accurate data are available The probability of this phe

nomenon serves as a reminder however that while the blood volume and hematocrit reading might be maintained the plasma protein can leak out of the denuded area to produce a severe depletion of natural serum proteins. With our present knowledge it would seem advisable to give whole blood or plasma to the patient treated with gelatin who survives the shock phase of his burn.

The use of gelatin solutions intravenously in no way alters the use of adequate local treatment to the burned area.

As a Supportive Measure in Operative Surgery—In patients about to undergo surgery under serial spinal anesthesia a gelatin infusion before or during the procedure has very frequently prevented the expected fall in blood pressure.

Especially in emergency surgery under any type of anesthesia the use of gelatin infusion during an operation we believe has aided many patients in coming through an otherwise difficult procedure without the added danger of an unstable pulse and falling blood pressure.

On several occasions during emergency surgery when gelatin solutions were used the response of the patient was impressive.

One case was that of a fifty-year-old female diabetic admitted in profound shock with an undiagnosed acute intra-abdominal lesion. A plasma infusion of 500 cc failed to effect her course favorably. Five hundred centimeters of 6 per cent gelatin solution was used for her second infusion and her blood pressure and pulse were restored to normal limits. With the patient's shock controlled operation was decided upon and after a delay of several hours necessitated by indecision on the part of the patient's family laparotomy was performed under cyclopropane anesthesia to disclose a mesenteric thrombosis with approximately 6 feet of devitalized bowel and a large intraperitoneal collection of serum fluid. Before the abdominal incision had been completed the patient was in such a state of shock that pulse and blood pressure were unobtainable and all bleeding from the wound stopped abruptly. This profound change occurred at the end of an infusion of 400 cc of plasma which had been started at the time of operation.

An infusion of gelatin was substituted for the plasma and within fifteen minutes there was sufficient restoration of blood pressure to permit brisk control of bleeding from the wound and a return of pulse and blood pressure to safe level. With the support of an additional infusion of 1000 cc of a 6 per cent gelatin solution resection and anastomosis of a segment of the small bowel was undertaken without further untoward reaction. The patient recovered.

Cases such as this are not common but the response to gelatin infusion illustrated in Figure 459 is not unusual. This patient underwent an emergency operation for release of a strangulated internal hernia under serial spinal anesthesia. It is interesting to note that one of the typical responses to gelatin, namely a rapid widening of the pulse pressure took place very shortly after infusion. Importance is attached to this sign in the treatment of shock and shocklike states as one of favorable prognosis.

Treatment of Edema—It is in this field especially where little is known about gelatin that there is need for further investigation.

Gelatin solutions have been effective chiefly in edema due to hypoproteinemia which may itself be due to many causes. We have at times been successful in treating edema due to starvation, liver cirrhosis and nephrosis as well as several cases of terminal anasarca in lymphosarcoma and Hodgkin's disease.

In the management of these problems daily infusions of 500 cc or 1000 cc of a 6 per cent gelatin solution was given keeping close watch on the serum albumin concentration for reasons to be discussed.

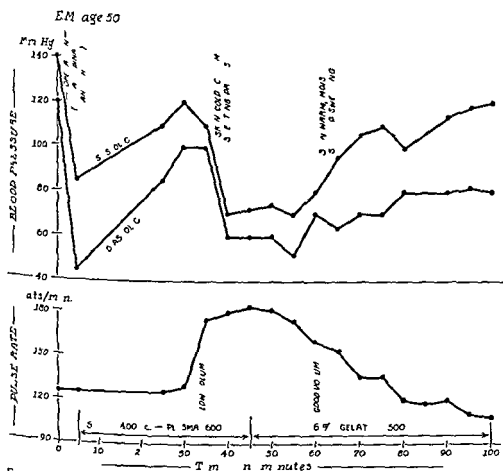


Fig 439—Effect of gelatin infusion on shocklike state previously treated with plasma

later. The use of mercupurin in doses of 2 cc after several gelatin infusions has resulted in greater diuresis in certain cases than either mercupurin or gelatin solutions alone.

Because of the increase in blood volume which follows gelatin infusions its use should be avoided in patients with edema of cardiac origin.

The large molecular gelatin produces greater diuresis than the small. In several instances administration of the small molecular gelatin has been followed by an increase in weight. The gelatin concentration of

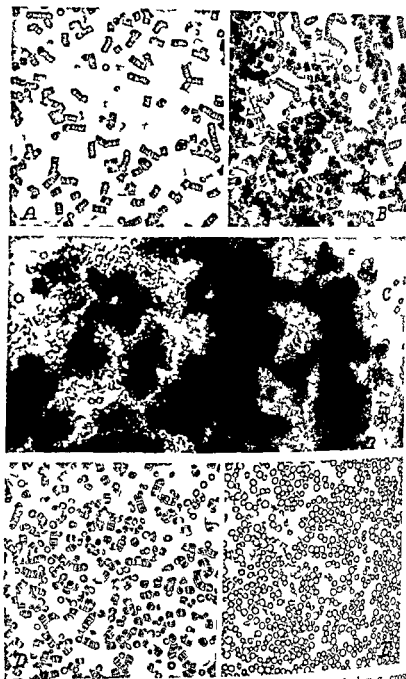


Fig. 460—Pseudo agglutination of erythrocytes encountered during cross matching of the blood in a patient who had received a previous gelatin infusion. *A* Pseudo agglutination of donor's cells in recipient's serum thirty minutes after mixing. *B* same in two hours. *C* actual clumping of incompatible blood. *D* effect of 5 per cent glucose on pseudo agglutination. *E* effect of 1 per cent glycine on pseudo agglutination.

edema fluid has been found to be greater after infusion with the small molecular material than after large molecular gelatin

We have been asked if gelatin has an effect on pleural effusions or abdominal ascites. No such hope was entertained and no beneficial effect has been seen although peripheral edema associated with either of these conditions may be benefited.

LIMITATIONS OF GELATIN SOLUTIONS

The Physical State of Gelatin Solutions—Gelatin solution as a plasma substitute in shock has but few limitations. The chief limitation is the physical state of gelatin at low temperatures. This affects its possible military field use rather than its use in hospitals. It is true that gelatin solutions have been made which are liquid at low temperatures but tests of comparative efficacy in shock definitely prove the superiority of the larger molecular material with the higher gel strength.

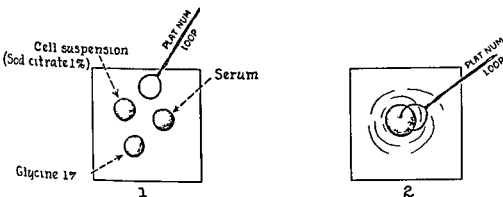


Fig 461—Method of cross matching blood using glycine

Pseudo agglutination and Blood Grouping—Gelatin solutions and the claims made for them as a plasma substitute have been the subjects of careful scrutiny by numerous investigators interested in gelatin per se or in the field of plasma substitutes in general. The question of possible interference with blood typing and cross matching in a patient who had received a gelatin infusion was seen as a definite problem.

Many macromolecular colloidal solutions and gelatin among them have been known to produce a phenomenon of pseudo agglutination of erythrocytes.¹¹ Pseudo agglutination can be described as the formation of long and short compact rouleaux which should not be confused with actual clumping such as one encounters in the course of blood typing (Fig 460).

The addition of a drop of 1 per cent glycine to any serum erythrocyte suspension prevents the formation of pseudo agglutination¹ and eliminates this criticism of the accuracy of blood grouping after gelatin infusion (Fig 461).

Gelatin is Not a Natural Serum Protein—It seems hardly necessary to call attention to the fact that gelatin is not plasma. It has been recommended as a substitute for certain of the functions of plasma. Gelatin apparently is as effective in the treatment of shock as is plasma. The nutritional function of gelatin solutions given parenterally has not been completely worked out as yet but there is accumulating evidence to suggest that gelatin solutions are suitable to substitute for the nutritional function of plasma in part. Gelatin solutions are not intended to substitute for plasma in aiding the coagulability of the blood or its defense against infection.

The practical aspects of this problem have already been mentioned. If a patient is losing natural protein through a burned surface or is losing albumin through his kidneys in nephrosis, gelatin cannot be expected to replace albumin in the circulation. For this reason when using large quantities of gelatin solutions in patients who continue to lose natural protein, frequent determinations of serum albumin concentrations should be made and plasma administered when needed to raise the albumin concentration.

PRECAUTIONS IN THE USE OF GELATIN SOLUTIONS

The chief precaution to be observed in the use of gelatin solutions is one suggested by the circulatory changes after gelatin infusion. The 6 per cent gelatin solution has twice the oncotic pressure of plasma, and therefore must be used with caution in patients of doubtful cardiac status. It should not be used at all in patients with any signs of cardiac failure, no matter how slight.

As it has been shown, the maximum blood volume increase occurs three hours after infusion and for that reason cardiac decompensation may occur some hours after the close of an otherwise uneventful gelatin infusion.

Paradoxically, the availability and low cost of gelatin solutions are in themselves sources of potential danger, for without need of blood donors or the necessary formality of obtaining plasma from the plasma bank, the clinician has a large supply of a powerful agent ready for immediate and continued use.

If the limitations of gelatin solution are kept in mind and it is used with the same judgment and precaution as plasma and for similar indications, it will prove an effective plasma substitute.

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THE USE OF THE SUMP DRAIN IN PERITONEAL INFECTION

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M.S. (Surgery) † and H. TAYLOR CASWELL MD ‡

OBJECTIVES OF SURGICAL DRAINAGE

There has never been any completely satisfactory method of drainage of the entire peritoneum in the treatment of infections. In general, the objectives of surgical drainage may be grouped as follows:

- 1 To remove exudate which may contain harmful toxins, necrotic tissue or living bacteria or cause mechanical interference with physiologic functions
- 2 To allow ventilation and/or irrigation for combating anaerobes
- 3 To produce by adhesions a limited space through which infectious material can be channeled at a subsequent time
- 4 To indicate type of exudate (blood, bile and so forth) from a hidden source
- 5 To avoid the accumulation of exudate in an unavoidable or potential dead space (amputations of breast extremities)

The objective in the treatment of peritonitis falls in the first classification. If expended phagocytes and other detritus and large numbers of dead and living bacteria can be withdrawn, the continued exudation will be less diluted by inert and harmful elements. It will contain a greater proportion of defensive factors such as active phagocytes and more antibodies due to higher titer as time passes. Less of toxins should be absorbed since absorption is much greater from pus under tension than from the same material without such tension. Lastly, there is elimination of the mechanical tendency for pressure to spread the exudate by dissection.

Although only vaguely suspected at first, these principles have influenced doctors to utilize drainage for peritonitis since the infancy of surgery. Unfortunately, the same protective process of adherence and loculation which surrounds and incinerates contaminated areas tends to defeat drainage by walling off into many compartments the irritated peritoneal cavity. Thus a drain consisting of an irritant foreign material was even more quickly sealed off from the remainder of the cavity, often in a few hours. Various methods were

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used first large gauze packs often impregnated with strong supposed antiseptics like iodoform rubber (gutta percha) tissue or tubes multiple drains placed at the many dependent sites at which localizations had occurred on previous patients¹ and even the very thorough and highly lethal method practiced by some between 1900 and 1910 consisting of opening the abdomen widely breaking up adhesions removing plaques of fibrin and thoroughly lavaging the entire peritoneum with many quarts of saline after which multiple gauze or rubber drains were inserted. Often abdominal stipes enemas and even purgatives were prescribed in the after treatment. The mortality was terrific often reaching 80 per cent.

As the radical use of local treatment has decreased the mortality has decreased also. However the apparent benefit resulting from drainage caused this maneuver to be retained as an important part of the treatment. Some feel that it is used too often and a few that it is entirely unnecessary and usually harmful^{3, 4}.

EARLY EXPERIENCE WITH DRAINAGE

Drainage in peritonitis is helpful in proportion to its efficiency. Gauze wicks tend to block drainage unless the exudate is thin and cause early firm adhesions. Rubber of various compositions is irritant and similarly is soon isolated. Drainage with such materials is of short duration profuse amounts appearing for only a few hours. This has led to the search for less irritant materials which will not cause such rapid isolation.

At the turn of this century rupture had already occurred in many appendicitis cases at the time of exploration so that experience with drainage was extensive. During this period glass tubes were used by Dr. John B. Deaver and others¹. These glass drains were aspirated every few hours to remove accumulated exudate. Unfortunately they were combined with gauze packs so that the whole combination was soon sealed off by the irritation of the gauze and probably some contribution from the peritoneal infection. After a few years the glass tubes were discarded since Dr. Deaver apparently felt they did not contribute to his improved results in appendicitis. These were probably the commonly used Keith tubes named after the English gynecologist. Many gynecologists of that day used them to prevent accumulation of blood and serum after pelvic operations⁵.

For many years thereafter rubber tubes rubber tissue cigarette drains and gauze were relied upon by the great majority of surgeons who believed in drainage. Occasionally gauze impregnated with petrolatum or other ointment was advocated. All these had the disadvantage that they were quite irritating to the peritoneum producing little drainage but dense adhesions which not infrequently caused postoperative intestinal obstruction. This complication accounted for

a definite proportion of the fatalities⁶ and furnished additional ammunition for the champions of the nondrainage treatment of peritonitis. Many observers had noted how little evidence of adhesions remained in the postperitonitic abdomen of those patients reoperated upon a short time later for various reasons or seen at postmortem after complications which proved fatal such as pulmonary embolism and intestinal obstruction. Often the only demonstrable adhesions were about the drainage site or the original source of contamination.

DEVELOPMENT OF THE SUMP DRAIN ITS ADVANTAGES AND THE IMPROVED RESULTS OBTAINED THEREWITH

Not for many years was there any radical departure from these revered methods. However in 1936 the ingenious Dr W Wayne Babcock began seeking a drain of less irritant character which would increase the efficiency of drainage and more nearly approach the theoretical objective of the method and which would be less likely to cause dense insulating adhesions. First glass and later stainless steel fenestrated tubes were tried alone without gauze or other material about them. Inside each was a proportionately smaller tube rubber at first then stainless steel connected to a motor driven pump for constant aspiration of the pus which accumulated in these larger tubes on the principle of a sump and this name was adopted for them.⁷

The negligible degree of irritation produced by stainless steel had been noted for several years since its introduction as suture material.⁸ Further the tubes completely enclosed in the peritoneal cavity of dogs under aseptic precautions were found two to four weeks later to be untarnished, freely mobile and without any evidence of surrounding peritoneal reaction. When used for drainage the tissues about the wound showed much less redness and swelling than we had been accustomed to observe.

Thus in the treatment of peritonitis it was not too surprising but still quite remarkable that large quantities of exudate were withdrawn by this method in spite of operative aspiration. As much as 100 to 200 cc in each twenty four hours for the first day or two has been recorded. Often fairly large amounts continue for three or four days. Instead of becoming thicker and more malodorous as seen with older type drains the material soon changes from purulent to serous the odor disappears with varying rapidity and the serous fluid quickly diminishes in volume. This indicates absence of isolation and continued procurement of exudate as it forms. On several occasions the drains have been removed in two or three days because the patient's condition was excellent, peristalsis had returned, the graphic sheet was practically normal and only a little serous drainage was obtainable.

In order to compare results ninety six cases of appendicitis with visible perforation are herein analyzed (table). We chose these be-

cause of their natural standardization. This choice excludes patients having gangrenous appendicitis with odorless but turbid fluid even though positive culture was reported the next day. We do not institute drainage in such patients unless there is suspicion of minute perforation. Under this circumstance a small sump may be inserted until the clinical course proves no gross contamination usually by the second or third day. Thirty four of these ninety six patients had rubber or gauze drainage (for seven cases of localized and twenty seven of diffuse peritonitis) and sixty two had sump drainage (for six cases of localized and fifty six of diffuse peritonitis). The mortality of the first group was 35 per cent and of the second 9.6 per cent. In this latter group the average days of drainage of the survivors were less by approximately two days and the duration of fever was about the same. In forty five cases the date of removal of the sump

NINETY SIX CASES OF GROSS PERFORATION OF APPENDIX

	Number of Cases	Hospital Stay	Duration of Fever Above 100° F	Duration of Drainage	Number of Deaths	Mor- tality Per Cent
Pre sump sulfonamide era	34	15.4	5.1	7.2	12	35
Sump-sulfonamide era	62	18.9	5.46	5.53	6	9.6
Sump drain and appen- dectomy without sul- fonamides	14	15	3.6	4.3	0	0
Sump drain and appen- dectomy with sulfon- amides	33	16.6	4.87	4.63	5	15.1

Average number of days

drains was stated on the chart. The average was 5.5 days. This includes one patient who required drainage for forty one days before secondary appendectomy was done without which the average was 4.7 days for the other forty four.

Fever was noted for an average of 5.5 days in fifty six patients and the hospital stay averaged 18.9 days including ten patients who were deemed too ill for appendectomy on admission. Three of these were subjected to appendectomy later their hospital stay being 5.6, 5.3 and 5.6 days without which the average stay was 16.9 days. Excluding all nine survivors who had no immediate appendectomy the average hospital stay was 16.3 days. The average stay of these nine patients was 32.2 days and only one of the ten died a mortality of 10 per cent.¹⁰

Since sulfonamides became popular soon after we began using sump drains we wondered if the obvious improvement resulted from

sump drainage or sulfonamides or both. In the above table comparison is made of fourteen of the cases of ruptured appendices treated by appendectomy and sump drainage with thirty three treated by appendectomy sump drainage and sulfonamides locally and/or systemically. The mortality of the first group is zero and of the second 15.1. These groups are rather small and are therefore not too significant but still quite intriguing. It is possible that we used sulfonamides on the sicker patients in whom a higher mortality is expected. However several preceded sulfonamide usage when such choice was not available.

In addition to the important factors of decreased mortality and morbidity other advantages of sump drainage are:

1 Removal of pus by positive means from the bottom of cavities instead of puddling and overflow from accumulation and body or intestinal movements as obtains with other methods. Thus even large but localized abscesses are more rapidly healed.

2 Frequent change of the small dressing is usually not required.

3 Ventilation and more adequate drainage decreases odor which is an important esthetic factor to many patients.

4 Pus is collected in a bottle with or without deodorant or antiseptic for easy disposal instead of on the dressings, cloth and bedding for general contamination of patient and attendants.

5 Postoperative hernia is much less likely—only two small ones were discovered at reoperation for appendectomy although they were not demonstrable before incision.

6 Postoperative obstruction is less likely. Two of the sixty two patients or 3.2 per cent were submitted to ileostomy on the fifth postoperative day because of continued marked distention but both had remained very septic and febrile and the one on whom additional blood count was done showed continued leukocytosis. Both cases were interpreted as inflammatory rather than obstructive ileus and both patients slowly recovered after ileostomy. Even construed as mechanical obstruction 3.2 per cent compares favorably with quoted statistics of 10 per cent¹¹ and 7.4 per cent.¹

7 Postoperative secondary abscesses are rare. The one pelvic abscess medial to the incision and the two pelvic abscesses observed in these sixty two patients occurred before we changed the location of the drain from right lower quadrant to the depths of the pelvis. Since this change there has been no pelvic abscess formation.

TECHNIC

In the extremely ill patients with diffuse peritonitis shock is treated with plasma, blood fluids and adrenocortin. Without removing the patient from bed local anesthesia is injected in the right lower quadrant for a 3 cm muscle splitting incision. Through this a long sump

drain is gently inserted into the pelvis being guided into the cul de sac by a finger inserted into the rectum. The sterile assistant can then anchor the drain to the skin with wire suture. No other sutures are needed. A modified Ochsner treatment including constant gastric or intestinal suction, fluids, nutrition and blood parenterally is applied. Systemic sulfonamides may be used or omitted. Appendectomy can be done when the patient has recovered sufficiently, but not less than a week should elapse.

For the average moderately ill patient, appendectomy is done under spinal anesthesia through a small muscle splitting incision. Pus which can be reached without trauma is removed by aspiration. A sump

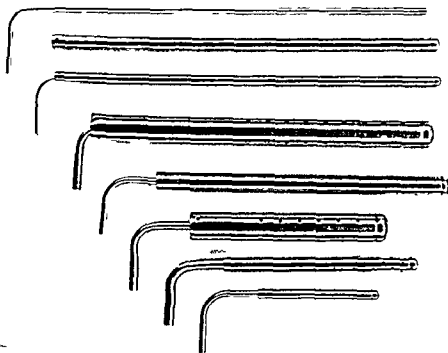


Fig. 462—Various sized sump drains. The perforations are 1, 1.5 or 2 mm in diameter.

drain is inserted into the pelvis thereby draining it and the right lower quadrant. Powdered sulfonamides may be applied and the wound is closed about the drain in layers using fine steel sutures. The drain is anchored to the skin with No. 32 wire. Modified Ochsner treatment is then utilized.

The drains themselves vary greatly in size both as to length and diameter and in the size of the perforations in the outer tube (Fig. 462). We have found that the larger sized perforations are more satisfactory for thick exudate. The smaller perforations are suitable in cases where a thin watery exudate is present, particularly in that composed of or containing bile. Perforations larger than 2 mm may

REFRIGERATION ANESTHESIA

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Ice and cold applications as therapeutic agents have been used in the practice of medicine from time immemorial. Hippocrates recommended their use in the treatment of injuries and Arabian physicians used them in the treatment of fever. Birthmarks and basal cell carcinomas were treated by carbon dioxide snow and furuncles were opened by refrigeration with ethyl chloride.

In 1938 Temple and his co-workers reported astounding results in the treatment of malignancy and infection by local and general refrigeration. They pioneered in the development of methods of applying refrigeration. In 1939 they reported a marked relief of pain of inoperable carcinoma of the uterus and the breast with definite clinical improvement. They stated that refrigeration caused the tumor to shrink in size in many instances causing disappearance of local growth without injury to the normal tissue.

Allen, Crossman and Ruggiero stated that refrigeration abolishes primary and secondary shock and slows or prevents the extension of infection in addition to being a very satisfactory and safe anesthetic. Blalock and Mason pointed out the value of refrigeration in traumatic shock.

The beneficial effect of cold on mental disorders in patients suffering from schizophrenia was reported by Talbott and Tillotson.

This method of treatment by hypothermia is referred to as hibernation that is reducing general body temperature by cooling to about 30 or 35° C.

Brooks and Duncan showed that the survival period of constricted rat tails was extended to four days if refrigerated to about 4° C. Without refrigeration the constricted rat tail became gangrenous in four hours. Prior to that Allen in his experimental work on dogs, rats and rabbits not only demonstrated these facts but pointed out the marked inhibition of shock, thrombosis, infection and injury to blood vessels and nerves.

The opinions or assertions contained herein are the private ones of the writers and are not to be construed as official or reflecting the views of the Navy Department or the naval service at large.

Refrigeration anesthesia is accomplished by the reduction of the local temperature of an extremity to about 5° C. by cracked ice ice water or by a controlled mechanical device. The latter is the most satisfactory, but most expensive. Refrigeration is not freezing. Freezing damages tissue and the freezing point of the latter is slightly below that of water.

LOCAL AND GENERAL EFFECTS OF REFRIGERATION

- 1 It produces lower metabolism which is similar to hibernation in lower animals
- 2 It reduces shock
- 3 It slows or prevents the extension of infection

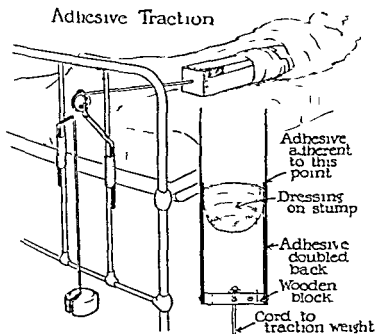


Fig 465—Skin traction used immediately after operation

- 4 It produces anesthesia by stopping cellular metabolism. Inactive cells do not respond to stimulation
 - 5 Pulse and blood pressure do not show any variation during operation
 - 6 Postoperative discomforts are minimized
 - 7 Refrigeration incisions heal more slowly than others for obvious reasons; therefore sutures should not be removed for about fifteen days in case of primary closure
- A modified Callander amputation without wound closure and the guillotine amputation also without wound closure are undoubtedly the safest methods and give the best surgical results. Skin traction is imperative following the guillotine amputation (Fig 465).

TECHNIC OF REFRIGERATION ANESTHESIA

A small caliber tourniquet (rubber tubing 17 mm in diameter) is applied to the desired site after that area has been chilled by an ice collar for one hour. The prechilling at the ligation level will reduce discomfort and minimize the pain. The tourniquet is applied sufficiently tight to stop the circulation and is properly secured to prevent slipping and refrigeration is immediately begun. The extremity is packed in cracked ice to at least 4 inches about the tourniquet. *Dry ice carbon dioxide snow or salt in the ice should never be used.* Any one of these may cause destruction of tissue by freezing. A skin temperature of the refrigerated extremity maintained at about 8 to 10° C. is very satisfactory. An ordinary thermometer held against the skin will determine the local temperature. Sometimes it is neces-

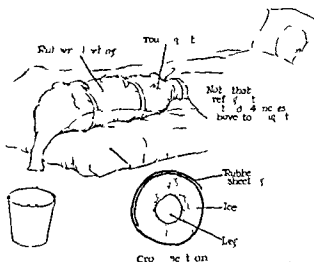


Fig. 466—A simple method of refrigeration by means of cracked ice and rubber sheeting.

sary to give a hypodermic of morphine in the beginning of refrigeration to allay pain and apprehension.

Mock gives the patient a drink of whiskey at the start of the refrigeration and repeats it if indicated. It is a good treatment and often makes unnecessary the administration of opiates. To permit a painless amputation about three hours of refrigeration are required in the average case. For the patient with a large muscular thigh however six hours may be necessary for complete anesthesia. Sometimes when the patient is desperately ill it is advisable to keep the extremity in refrigeration for nine hours or more. It is often noted that with refrigeration their general condition improves and in some cases the improvement is spectacular.

One simple procedure for refrigeration is packing the extremity in cracked ice wrapped in rubber sheeting (Fig. 466). Lately we have

been using a homemade metal box encased in a wooden frame (Fig 467) and it has proved to be much more satisfactory. Some surgeons use ice water others gum rubber ice packs and still others use mechanical means. The last named has the advantage of providing controlled temperatures and the disadvantage of being an expensive apparatus. Ice is not removed until the patient arrives in the operating room and the anesthesia obtained usually lasts for about one hour. Allen recommends that the skin incision be made about 15 cm distal to the tourniquet. It is advisable to apply ice packs over the

Home made ice box for
Refrigeration Anesthesia

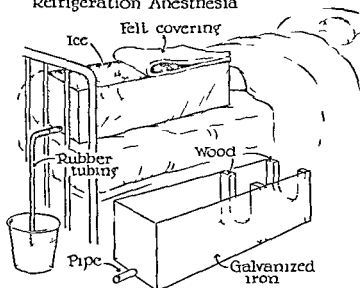


Fig 467—A homemade container for refrigeration anesthesia. Made of metal and encased in wood.

dressing of the stump for several days. This decreases discomfort and diminishes postoperative seepage and edema, but it has the disadvantage of inhibiting healing.

INDICATIONS FOR REFRIGERATION ANESTHESIA

- 1 Elderly debilitated patients
- 2 A severely traumatized extremity with associated injuries and shock when amputation is indicated
- 3 Diabetic or arteriosclerotic gangrene or a combination of them
- 4 Severe sepsis and gas gangrene
- 5 Gangrene due to thromboangitis obliterans
- 6 A severely crushed extremity. In such instances the immediate application of the tourniquet and packing with ice are often a life saver. In addition to inhibiting shock they prevent the absorption of histotoxin which often causes considerable kidney damage and secondary shock.

ADVANTAGES OF REFRIGERATION ANESTHESIA FOR AMPUTATION

- 1 It inhibits primary and secondary shock
- 2 Complete anesthesia is possible with absence of pain during the operation and postoperatively
- 3 It permits surgery in poor risk cases that used to be considered hopeless
- 4 It lowers the incidence of infection and mortality
- 5 It renders postoperative convalescence less stormy
- 6 Temperature pulse and respiration do not show any variation during an operation under refrigeration anesthesia
- 7 It permits the delaying of amputation until associated injuries and conditions which are threatening life receive the necessary treatment

CLINICAL ANALYSIS OF FIFTY THREE AMPUTATIONS OF THE LOWER EXTREMITY OF SURGICALLY HANDICAPPED PATIENTS

The indications for amputation in the fifty three cases were as follows: severe trauma (one case), gangrene from arteriosclerosis (twenty seven cases), thromboangitis obliterans (eight cases), diabetes (six cases), arteriosclerosis and diabetes combined (nine cases), and popliteal aneurysms (two cases). The nine most desperately ill patients were submitted to surgery under refrigeration anesthesia. These cases ordinarily would have been considered hopeless. Several patients in this group were moribund when admitted to surgical service. Two of these patients died and the rest recovered.

An analysis of the fifty three amputations follows:

Initials	Age	Diagnosis	Type of Amputation	Anesthesia	Outcome
CH	86	Gangrene right foot Arteriosclerosis	Modified Callander	Local	Recovered
MT	53	Gangrene both feet Arteriosclerosis	Modified Callander	Local	Died on 19th PO day
FB	49	Gangrene left leg Thromboangitis obliterans	Modified Callander	Spinal	Recovered
IG	48	Ulcer left foot Arteriosclerosis	Modified Callander	Local	Recovered
HC	39	Gangrene right foot Thromboangitis obliterans	Modified Callander	Spinal	Recovered
WH	53	Gangrene left foot Arteriosclerosis	Modified Callander	Spinal	Recovered
CS	49	Gangrene left foot Diabetes mellitus	Modified Callander	Spinal	Recovered
HG	40	Gangrene left foot Thromboangitis obliterans	Modified Callander	Spinal	Recovered

Initials	Age	Diagnosis	Type of Amputation	Anes- thesia	Outcome
AS	47	Gangrene right foot Thromboangitis obliterans	Modified Callander	Spinal	Recovered
LW	47	Gangrene right foot Arteriosclerosis	Modified Callander	Spinal	Recovered
RS	45	Gangrene left foot Diabetes mellitus	Modified Callander	Spinal	Recovered
JM	49	Gangrene right foot Arteriosclerosis	Modified Callander	Spinal	Recovered
PL	25	Dry gangrene left foot Thromboangitis obliterans	Modified Callander	Spinal	Recovered
LW	47	Gangrene left foot Arteriosclerosis	Modified Callander	Spinal	Recovered
EC	71	Gangrene left foot Arteriosclerosis	Modified Callander	Spinal	Recovered
HG	59	Gangrene right foot Arteriosclerosis	Modified Callander	Spinal	Recovered
MN	44	Gangrene left foot Arteriosclerosis	Modified Callander	Spinal	Recovered
AS	48	Gangrene left foot Arteriosclerosis	Modified Callander	Spinal	Recovered
FM	47	Gangrene right foot Diabetes mellitus	Modified Callander	Spinal	Recovered
EL	45	Gangrene left foot Arteriosclerosis	Modified Callander	Spinal	Recovered
JC	50	Gangrene left foot Diabetes mellitus and arteriosclerosis	Modified Callander	Spinal	Recovered
BL	45	Gangrene left foot Diabetes mellitus	Modified Callander	Spinal	Recovered
WS	63	Gangrene left foot Diabetes mellitus with arteriosclerosis	Modified Callander	Spinal	Recovered
JN	46	Gangrene right great toe Thromboangitis obliterans	Modified Callander	Spinal	Recovered
MN	45	Gangrene right foot Arteriosclerosis	Modified Callander	Local	Recovered
LC	53	Gangrene left foot Diabetes mellitus with arteriosclerosis	Modified Callander	Spinal	Recovered
MW	64	Gangrene left foot Diabetes mellitus with arteriosclerosis	Modified Callander	Spinal	Recovered
WD	57	Gangrene left forefoot Arteriosclerosis	Modified Callander	Spinal	Recovered
CH	86	Gangrene right foot Thromboangitis obliterans	Modified Callander	Spinal	Recovered
JP	4	Gangrene left leg Arteriosclerosis	Modified Callander	Spinal	Recovered
JC	65	Gangrene left foot Arteriosclerosis	Modified Callander	Spinal	Recovered

Initials	Age	Diagnosis	Type of Amputation	Anesthetics	Outcome
R I	49	Gangrene left foot Arteriosclerosis	Modified Callander	Sodium pentothal	Recovered
C L	4	Gangrene left leg Arteriosclerosis	Gumshot	Spinal	Recovered
W S	6	Gangrene left leg Diabetes mellitus with arteriosclerosis	Modified Callander	Local	Recovered
R H	44	Gangrene right foot Hypertension obliteration	Modified Callander	Spinal	Recovered
M M	46	Gangrene right foot Arteriosclerosis	Modified Callander	Ref. general	Recovered
B I	43	Gangrene right foot Diabetes mellitus with arteriosclerosis	Modified Callander	Spinal	Recovered
J S	43	Gangrene left foot Arteriosclerosis	Modified Callander	Spinal	Recovered
M H	65	Gangrene right foot Aneurysm right popliteal artery	Modified Callander	Spinal	Recovered
C C	53	Gangrene right foot Aneurysm right popliteal artery	Modified Callander	Spinal	Recovered
C C	5	Gangrene left foot Arteriosclerosis	Modified Callander	Ref. general	Recovered
H B	47	Gangrene right foot Arteriosclerosis	Modified Callander	Spinal	Recovered
C A	56	Gangrene right foot Arteriosclerosis	Modified Callander	Spinal	Recovered
A I	52	Gangrene left foot Diabetes mellitus with arteriosclerosis	Modified Callander	Ref. general	Died on P.O.D.
B R	50	Gangrene left foot Diabetes mellitus	Modified Callander	Ref. general	Recovered
T D	47	Gangrene left foot Arteriosclerosis	Modified Callander	Ref. general	Recovered
H B	49	Gangrene left foot Arteriosclerosis	Modified Callander	Ref. general	Recovered
J P	48	Gangrene right foot Arteriosclerosis	Modified Callander	Spinal	Recovered
F S	48	Gangrene left foot Severe diabetes mellitus	Modified Callander	Spinal	Died on P.O.D.
T D	48	Gangrene right foot Arteriosclerosis	Modified Callander	Ref. general	Recovered
T J	42	Gangrene right foot Laceration of popliteal artery	Gumshot	Ref. general	Recovered
H D	56	Gangrene left foot Diabetes mellitus with arteriosclerosis	Modified Callander	Ref. general	Died on P.O.D.
W J	55	Gangrene left foot Diabetes mellitus with arteriosclerosis	Gumshot	Ref. general	Recovered

The following reports illustrate the value of refrigeration anesthesia in the case of desperately ill patients who must undergo amputation

CASE I—A fifty six year-old veteran was admitted complaining of pain and ulceration of right foot and leg. He gave a history of having been treated for several years for diabetes and arteriosclerosis. He appeared to be desperately ill with a temperature of 104° F and a pulse of 140. Examination revealed advanced arteriosclerosis and diabetes with gangrene of right foot and leg and a rapidly spreading infection. Dorsalis pedis and posterior tibial pulses were absent with an oscillometric reading of 1½ at knee. Refrigeration anesthesia for a period of four hours which was followed by low right thigh amputation modified

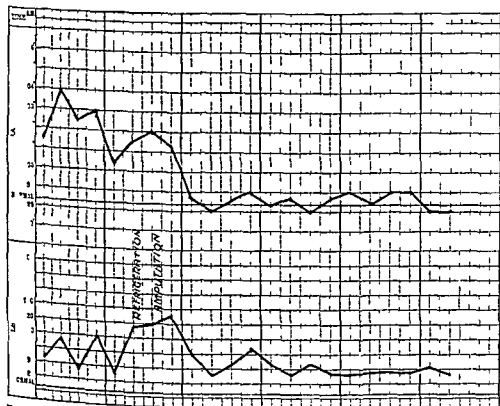


Fig 468—Chart showing effect of refrigeration on pulse and temperature in a case of arteriosclerotic gangrene of right foot and leg with spreading infection

Callender type. Immediate postoperative reaction excellent and convalescence was uneventful. The patient was permitted out of bed in a wheel chair the second day after operation. (See the chart in Fig 468.)

CASE II—A seventy five year old veteran was admitted complaining of pain and ulcers of the dorsum of the left foot of several months duration. The foot was cold and arterial pulses were absent in the posterior tibial and dorsalis pedis and poor in the femoral artery. Cardiac examination disclosed moderately advanced arteriosclerotic heart disease. Blood pressure was 124/70. X-ray findings of extremity showed advanced arteriosclerotic peripheral vascular disease. Gangrene became progressive with spreading infection. The patient's general condition was becoming progressively worse. Amputation a modified Callender type was performed under refrigeration anesthesia and the patient was per

mitted to be in a wheel chair the day following operation. Convalescence was uneventful. The findings in the amputated leg showed severe arteriosclerotic changes with thrombosis.

CASE III—A forty-seven year-old veteran was admitted with ill advanced gangrene involving the right foot and distal third of the right leg. The patient stated that six years previously he developed phlebitis in both legs which later was associated with ulcers. Since that time the ulcers showed some improvement, but never completely healed. The patient appeared seriously ill, toxic with a rapid pulse and a temperature of 101° F. Examination of right leg showed spreading gangrene involving the dorsum of the foot and distal third of leg with absence of pulses in the dorsalis pedis and posterior tibial arteries. Cardiac examination revealed evidence of well advanced coronary heart disease. X-ray examination of extremities showed advanced arteriosclerotic vascular disease. Three and one half hours after refrigeration anesthesia was begun, a modified Callander amputation was performed on the lower right thigh. The patient was placed in a wheel chair on the second day following operation. Convalescence was uneventful.

Four months later the patient was readmitted with a similar condition in the left lower extremity and with similar clinical symptoms and findings. He did not respond to conservative treatment. Gangrene and infection of left foot and ankle were spreading. After six hours of refrigeration a modified Callander amputation was performed. Convalescence was uneventful.

CASE IV—A fifty-two year-old diabetic veteran was admitted in a moribund state with gangrene of left foot extending to the leg and a rapidly spreading infection. The patient had been treated previously by a chiropodist and developed an infection of the left large toe. Attempts at control of the diabetes failed. The patient appeared desperately ill with a high temperature (103° F.) and a rapid pulse (150). Refrigeration of the left lower extremity was used only slight clinical improvement. A modified Callander amputation was performed. The patient died twenty-four hours after operation from congestive heart failure.

CASE V—A fifty year old veteran suffering with arteriosclerosis and diabetes was admitted complaining of pain ulceration and gangrene of left foot which was gradually becoming worse. Examination of left foot showed an extensive gangrenous process involving the great second and third toes and dorsum of the foot with diffuse purulent drainage from the ulcer area on plantar surface of the foot. Blood sugar ranged from 40 to 374 mg per 100 cc. A modified Callander amputation was performed after four hours refrigeration. Convalescence was uneventful. The pathological report showed gross gangrene of the left foot and leg with advanced arteriosclerotic changes and an old and recent thrombosis.

CASE VI—A forty seven year-old male was admitted on October 3, 1944 complaining of burning and pain in the left leg of ten days duration. There was bluish discoloration of the left foot and ankle with swelling and the extremity was very cold. Dorsalis pedis and posterior tibial and popliteal pulsations were absent although femoral artery pulsations could be palpated. Conservative treatment failed and lumbar parasympathetic block failed to relieve the pain and spreading gangrene. On October 15, 1944 a modified Callander amputation was performed after four hours refrigeration. The patient was discharged on November 12, 1944.

On January 24, 1944 the patient was readmitted with a complaint of intermittent pain in the right leg after walking. The pain in the right foot became more intense with evidence of dry gangrene of the first second and third toes. X-ray

examination revealed evidence of marked arteriosclerosis of the right leg. Because of the persistent pain and the development of moist gangrene in the foot, a modified Gallander amputation was performed on May 5 1944 under refrigeration and esthesia. Convalescence was uneventful. Pathological examination showed evidence of marked arteriosclerosis with thrombosis.

CASE VII—A fifty-six year-old diabetic and arteriosclerotic veteran was admitted on September 13 1944 in a critical condition. Examination showed congestive heart failure edema of both ankles with liver enlargement three finger breadths below costal margin. Pulsations were absent in the posterior tibial and dorsalis pedis arteries in both legs. Blood sugar was 15 m% and urea nitrogen 5 mg per 100 cc. A ray examination showed advanced arteriosclerotic peripheral vascular disease. The patient was irrational and in a moribund condition. Examination of the left leg showed gangrene of the dorsum of the foot with evidence of gas infection. On September 14 a tourniquet was applied just below the knee and "refrigeration" was started. The patient improved slightly and the nurses felt that maximum level of improvement had been obtained. On September 18 1944 a tourniquet was applied to upper thigh and after four hours of refrigeration a guillotine amputation was performed. The postoperative condition remained desperate and the patient died fourteen hours after operation from congestive heart failure and overwhelming infection.

CASE VIII—A forty-two-year-old male was admitted following the crushing of his right leg by an ambulance bumper with destruction of all the blood supply in the popliteal area. He complained of severe pain in the knee and loss of sensation in leg and foot. Examination showed the right leg and foot to be pulseless and cold with evidence of gangrene and early infection. After "refrigeration" and esthesia for a period of five hours a guillotine amputation was performed in the lower thigh. The rapid pulse and high temperature subsided and the patient had an uneventful convalescence.

CASE IX—A fifty-five year-old male was admitted on September 11 1944 complaining of sharp pain in the left leg for the past four days. He has been a known diabetic for several years and had been on insulin therapy which he discontinued about four months ago. The heart was slightly enlarged and the liver was palpable below the costal margin. The left leg was pale and cold to the touch. No pulsations were palpable in the left leg and only the femoral pulse was present on the right. The emergency blood sugar test gave a value of 50 mg per 100 cc. Parasympathetic block of the left lumbar region relieved the pain but caused no appreciable change in color or temperature of the left leg. After four hours of "refrigeration" a midthigh guillotine amputation was performed and skin traction instituted. Convalescence was uneventful.

CONCLUSIONS

Refrigeration anesthesia is a recent and important contribution to surgery. It has rendered operations possible in surgically handicapped cases which previously were considered hopeless. In that group when surgery was attempted the mortality was appalling. In this same type of case with the aid of refrigeration anesthesia the mortality has been reduced to a low level. Its usefulness in the future will probably extend to include any type of major amputation.

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COMPOUND INJURIES OF THE SKULL AND THEIR MANAGEMENT*

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Most injuries resulting from serious accidents are treated at the nearest hospital. Because of the shortage of the meticulously trained specialists—specialist—the neurosurgeon—the available attending surgeon is the individual most often called upon to care for acute head injuries. Thus the treatment of a great majority of these injuries is not primarily a problem of the neurosurgeon but rather of the general surgeon. Therefore especially at the present time it is fitting that this important subject should be presented as managed by the general surgeon.

Most compound fractures are contaminated at the time of infliction; however secondary infection must be prevented by avoiding gross infections from attending physicians, hospital personnel and frequent redressings. The same fundamental surgical principles applicable to open wounds or injuries of all regions of the body also apply to compound injuries of the cranial region, namely attention to the cardinal factors in promotion of wound healing which are immediate disinfection, immediate and as nearly as possible complete immobilization and the withholding of meddlesome procedures. These may be accomplished by the use of a sterile dressing on the wound at the time of injury and following definitive treatment the employment of the sterile petrolatum gauze pack, sutures without tension and an all inclusive dressing.

THE STERILE PETROLATUM GAUZE PACK TREATMENT

Soon after World War I Winnett Orr¹ advocated the wide open sterile petrolatum gauze pack treatment for compound fractures of the long bones following his success in the treatment of osteomyelitis.

The opinions and assertions contained herein are the private ones of the writers and are not to be considered as official or reflecting the views of the Medical Department of the Navy or the Naval Service at large.

Patients presented at the Philadelphia Academy of Surgery, March 6, 1944.
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6 The petrolatum gauze pack is brought out like a bolster and held in place with the tension sutures (Fig 474). The peripheral parts of the tripod incisions are loosely approximated with interrupted silk sutures.

7 Sterile plain dry gauze dressings and bandage are applied to the entire scalp area forming a Frazier head cap (Fig 475). This type of dressing becomes a rigid bandage within forty-eight hours by the absorption of secretions from the wound. Thus a dressing approximating the plaster cast is formed.

8 The dressings remain undisturbed for fifteen days after which all dressings, sutures and the petrolatum gauze are removed. At this first dressing the wound is gently irrigated with aqueous azochloramid

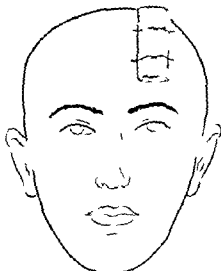


Fig 474

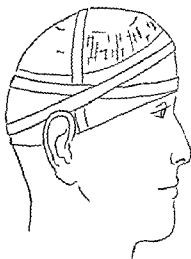


Fig 475

Fig 474—Petrolatum gauze pack (cont.)

Fig 475—Frazier head cap

solution and sterile petrolatum gauze strips. Sterile dry gauze and the Frazier cap reapplied. Weekly dressings are done thereafter.

9 These wounds are allowed to heal by secondary intention if small in area or some plastic procedure is performed if the defect is large.

REPORT OF CASES

CASE 1—On October 1, 1941, G. A. White, 21 years of age, was struck on the head by a plank falling from a roof and was rendered unconscious for about fifteen minutes. He was transferred to the Methodist Hospital, Philadelphia. Upon hospital admission, the patient had regained consciousness but was very restless. The temperature was 98.6 F, pulse rate 100 per minute, blood pressure 100/60. There was a large laceration of the scalp in the right temporal region, approximately 4 inches in length, with several smaller superficial lacerations. Palpation of the wound with the sterile glove revealed a comminuted fracture of the skull. The scalp was

sterile gauze saturated with alcohol. As the general condition of the patient gradually improved he was prepared for operation and roentgenogram of the skull was taken.

Operation was performed under ether anesthesia. There was a compound comminuted depressed fracture of the right temporoparietal region. Three of the depressed fragments were completely detached. The upper posterior fragment was depressed without detachment, however the inner table was more severely damaged than the outer table. No demonstrable laceration of the dura nor any evidence of subdural bleeding could be found, but there was extradural hemorrhage which was insufficient to produce symptoms of compression. The external wound was extensively undermined and the galea stripped from the cranium over an area approximately 4 inches in diameter.

The operation was performed as follows. The head was completely shaved and the skin surrounding the wound was prepared. The wound margins were excised and the entire wound was laid open. Laceration in the galea was extended to permit complete exposure of the fractured area. The detached fragments were removed and the depressed but not detached fragment was elevated. A dural elevator passed between the skull and the dura at this point showed no compression in this area. After hemorrhage was controlled the wound was liberally dusted with 7 gm of sulfanilamide crystals and then packed wide open with sterile petrolatum gauze and the scalp closed with interrupted silk sutures along the lines of extension. The area of the actual excision was left open as it was packed with petrolatum gauze which in turn was held in place with two figure of 8 tension sutures. Sterile dressings and a Frazier cap were applied. Fifteen hundred units of tetanus antitoxin were given. Sulfathiazole was given by mouth 6 gm daily for four days and 3 gm for five days postoperatively. The local application of sulfonamides has since been discontinued. Culture of the wound taken at the time of operation showed *Staphylococcus aureus*.

The first postoperative dressing was done fifteen days later when all dressings, sutures and petrolatum gauze were removed. The wound was smaller in size with clean healthy pinkish granulation tissue. Culture taken from the wound at this time showed *Staphylococcus aureus*, diphtheroid bacilli and *B. subtilis*. The wound was gently irrigated with aqueous azochloramid solution and the surrounding area of the scalp was cleaned with alcohol sponges. Sterile petrolatum gauze strips, sterile dressings and Frazier head cap were applied. The next dressing was done a week later at which time the wound was healing rapidly. On the twenty seventh day the wound was practically healed. A small dressing was applied to the head and the patient was discharged with instructions to return to the follow up clinic.

CASE II—C P a white girl aged six years was hit by a truck on March 18 1943. She was brought to the Accident Ward of the Woman's Hospital of Philadelphia at 2 P.M. in a state of unconsciousness and restlessness. On admission the temperature was 97° F pulse rate 100 respirations 28 blood pressure 124/80. Sodium luminal was given for the restlessness. On inspection the patient had a laceration of the scalp extending from the right forehead to the middle of the scalp (right paramedial) and a laceration posterior to the ear forming a T shaped laceration on the scalp. Bone fragments were clearly shown through the large laceration. The right elbow was swollen and the patient experienced pain on motion. A sterile dressing saturated with alcohol was placed on the scalp wound and an internal right angle splint applied to the right arm. The patient's general condition improved as she regained partial consciousness and there was no appreciable change in the physical signs.

At 4:30 P.M. the patient was transported to the x-ray room and from there to the operating room. The operation was performed under ether anesthesia.

The scalp was shaved, cleaned with soap water, alcohol, ether and alcohol and the wound there was a compound comminuted fracture of the right

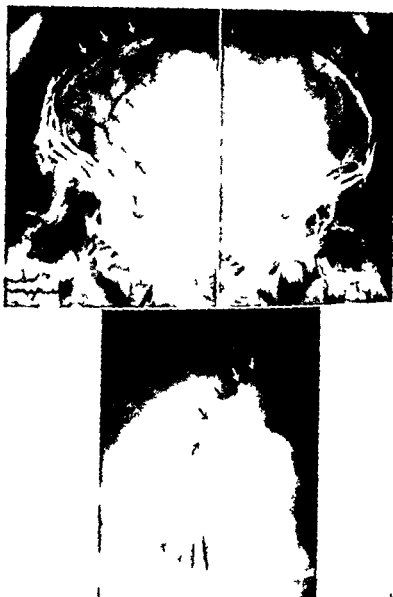


Fig. 4-6 (Case H. C. P.)—Preoperative. Compound fracture of the right frontal region. There is a linear fracture parallel to the base of the skull about 0.5 cm above the floor. There are two oblique fractures parallel to the frontoparietal suture, one about 1 cm posterior to the suture, the other about 4 cm. The inner table of the frontal bone is more damaged than the outer table, there being several depressed fragments in the frontal bone above the orbit.

frontal bone (Fig. 4-6). The inner table of the frontal bone was more damaged than the outer table. The inner table was also depressed with several fragments

of bone The entire right parietal bone was depressed and at the junction of the right frontoparietotemporal regions there were several depressed fragments of the parietal bone The *dura* was intact and normal in color and texture The wound was excised en masse including the lacerated scalp contused tissue hair



Fig 47 (Case II C P) —One year later Depressed fragments of the frontal bone removed and the frontoparietal plates restored to their normal position

and fragments of bone The wound was aspirated clean by means of suction and gently irrigated with ether and small amounts of physiological saline solution The major portion of the fragmented bone was removed en bloc the depressed parietal bone was elevated into position It was necessary to remove part of the outer table of the frontal bone in order to remove the depressed

fragments of the inner table. Four grams of crystalline sulfanilamide were distributed throughout the wound. Sterile petrolatum gauze was placed in the equal space and beneath the scalp. The posterior portion of the scalp was loosely approximated with interrupted silk sutures and a figure-of-8 silk suture over the petrolatum gauze. Sterile gauze dressing and a Frazier head dressing were applied. Roentgenograms revealed a linear fracture of the lateral condyle of the right humerus which was treated accordingly. Fifty hundred units of tetanus antitoxin were given in addition to sodium luminal and codeine for restlessness. Sulfadiazine was given by mouth for five days. Culture taken at operation showed *Staphylococcus aureus*.

The first dressing of the scalp wound was made on the fourth day. All dressings, sutures and petrolatum gauze were removed. The wound was covered with clean healthy granulation tissue. Culture of the wound taken at this time again showed *Staphylococcus aureus*. The wound was gently irrigated with a pectus azochloramide solution and the surrounding area cleaned with alcohol sponges. Sterile petrolatum gauze strips were applied over the granulating wound. Dry gauze dressings and a Frazier cap were applied. Culture taken at the second dressing, sutures and petrolatum gauze were removed. The wound as covered was clinically healthy and granulating rapidly. On the thirty-first postoperative day the exuberant granulation tissue was trimmed and the dressings instilled. A plastic closure of the wound of the forehead was performed by a sliding flap. Pressure dressing was applied over the wound and sulfadiazine was given by mouth as a prophylactic measure. Although the culture of the wound indicated that *Staphylococcus aureus* persisted throughout the convalescent period there was no systemic reaction nor any local deleterious effect on the wound or surrounding tissues. All dressings and sutures were removed one week later and the wound was well healed. The patient was discharged from the hospital on the fifty-second day. Roentgenogram taken one year later (Fig. 477) shows that the depressed fragments of the frontal bone were removed and the frontoparietal plates restored to their normal position.

Case III—A 72-year-old white man aged forty years, as struck on the head by a large chain flying loose from the dredge in which he was working on June 30, 1941. He was brought immediately to the Accident Ward of the Methodist Hospital. On admission at noon, the patient was very restless and in semiconscious state. The temperature was 96° F., pulse rate 90, respirations 20. Blood pressure 130/80. There was a large laceration of the scalp in the right parietal region surrounded by multiple small superficial lacerations and ecchymosis of both periorbital spaces. The wound in the scalp extended deep into the skull. A diagnosis of compound comminuted depressed fracture of the skull was made by palpating the wound with a sterile gloved finger. The scalp wound was covered by a sterile gauze compress saturated with alcohol. The patient was given 100 cc. of 50 per cent sacro-c solution intravenously. Sodium luminal and morphine sulfate were given for restlessness as an indication operation was contemplated. Fifteen hundred units of tetanus antitoxin were also given. At three o'clock in the afternoon the patient's general condition improved.

At 3:30 P.M. the patient was moved to the operating room and then directly to the operating room in his bed. Operation disclosed a compound comminuted depressed fracture of the vault of the skull the inner table more severely damaged (Fig. 478) in the right frontoparietal region with marked extradural hemorrhage posterior to the line of fracture. Block excision of the wound was performed completely detached fragments were lifted out and the defect of the skull enlarged by rongeur in order to control the bleeding. The posterior skull was ligated by transection suture and a strip of iodoform gauze



Fig 4 8 (Case III A T) —Preoperative Comminuted depressed fracture of the vault of the skull In the right frontoparietal region the inner table is more severely damaged than the outer table



Fig 4 9 (Case III A T) —Postoperative Defect in the skull following en bloc excision of the depressed fragmented bone area.

packing inserted between dura and skull to control extraneous bleeding. A small laceration of the dura which had been caused by a fragment of the inner table of the skull was closed with two fine silk sutures. Eight grams of erythromycin sulfanilamide were distributed in the wound. The wound was packed with sterile petrolatum gauze and the dressing completed with dry sterile gauze and a Trazier cap. The patient was given 1500 units of tetanus antitoxin and sulfathiazole was given by mouth for one week. Culture taken at the time of operation showed hemolytic streptococcus and Staphylococcus aureus. Ten days postoperatively the dressing was removed without disturbing the petrolatum gauze packing. On the fifteenth day all of the dressings including the petrolatum gauze packing were removed. The wound appeared clean, with healthy granulation tissue. Culture at this dressing showed hemolytic streptococcus, Staphylococcus aureus and B. subtilis. Thereafter the wound was dressed weekly with sterile petrolatum gauze strips and dry sterile gauze. The wound healed by secondary intention and the patient was discharged from the hospital on the fortieth postoperative day. Roentgenograms of the skull were taken at this time (Fig. 49).

CASE IV.—A white man aged eighteen years was accidentally hit in the head while cleaning a .038 caliber revolver on January 5, 1943. He was brought by the police to the Accident Ward of the Methodist Hospital as a state of unconsciousness. On admission there was active bleeding from two circular wounds of the scalp in the left frontoparietal region. These wounds were about 4 cm apart. The skin around this area was contused and there were periorbital edema around the left eye, lower eyelid edema of the left periorbital spaces. The pupils were equal, normal in contour and reacted normally to light. All other reflexes were normal. The temperature was 96.4 F, pulse rate 90, respiration 18, blood pressure 118/80. A sterile compress saturated with alcohol was placed over the wound and a compression bandage applied. In about one-half hour the patient became semiconscious and after some questioning and the temperature rose to normal. There were no appreciable changes in the other physical signs.

Immediate operation was decided upon. The patient was given 5 grams of sodium iodine and 1 grain of colchicine sulfate transferred to the X-ray room (Fig. 480) and subsequently to the operating room.

The scalp was shaved, cleaned with soap water, ether and alcohol and then sutured. Under local anesthesia the wound incorporating the two bullet holes of the scalp was excised en masse including the galea aponeurotica. As the fracture was slightly posterior to the scalp wound the scalp incision extended posteriorly in order to obtain better exposure. The loose bone fragments were removed. About 1 cm posterior to the distal perforating wound there was found brain substance and a compound comminuted depressed fracture of the skull. The skull was lodged in this area (Fig. 480). The area of the skull was removed en bloc. The dura mater was torn and contused, leaving a defect of approximately 2 cm. An area of the cortex about the size of a silver dollar beneath the torn dura was reduced to a pulp. There was free bleeding from the small blood vessels beneath the dura and free leakage of cerebrospinal fluid through the inner table of the skull was more depressed and fragmented than the outer table. It was necessary to enlarge the defect in the skull by retractor in order to obtain better exposure of the dura and to remove depressed fragments of the inner table of the left frontal bone. Bleeding from the two small vessels of the dura was controlled by means of the suction apparatus and the Bovie unit. The area of the brain was cleared of all contused brain tissue. Blood clots, small fragments of the lead bullet, spicules of bone and soft tissue by means of the suction apparatus (Fig. 47). A small amount of physiological saline solution was used.

in gentle irrigation and suction of the tract the patient cooperated in this procedure by coughing in order to help force the material out of the tract. No attempt was made to remove other fragments of the bullet located in the temporo-occipital regions as shown by the roentgenograms (Fig. 481).

A stamp graft taken from the galea was cut to pattern and placed over the defect in the dura and secured with interrupted No. 000000 black silk sutures. The patient was asked to cough in order to determine whether or not the closure was water tight. The wound was packed open with sterile petrolatum gauze which was held with two interrupted figure of 8 silk sutures. Sterile Iry dressing and a Frazier cap. Fifteen hundred units of tetanus antitoxin were given and sulfathiazole was given by mouth for one week.



Fig. 480 (Case IV J A).—Preoperative. Fragments of the bullet located. The inner table of the frontal bone is more severely damaged and fragmented than the outer table.

On the fifteenth day all dressings, sutures and packing were removed. The wound appeared clean with healthy granulation tissue. Although there were granulations over the wound and the dura was pulsating, nevertheless there was no leakage of cerebrospinal fluid. The wound was cleaned and sterile petrolatum gauze strips applied to the wound and covered with sterile dry gauze. Dressings were made in the same manner at weekly intervals and the patient was discharged on the forty-eighth postoperative day. He was completely free from subjective or objective symptoms. Although the wound of the scalp had completely healed by secondary intention, there was a defect in the skull. Pulsations were visible through the scar and there was very little protection to the dura and brain. The patient was readmitted to the hospital five months following his accident. At that time the scar defect was the size of a silver dollar. Pulsations were visible and were aggravated by coughing or straining. On June 1, 1943, the scar

was revised and the wound treated with wet dressings of aqueous zephiran in 1:4000 solution for twelve days. Under local anesthesia a pedicle graft was cut and placed above the defect and was turned upon itself with the pedicle line at the upper end of the scar and the skin surface on top of the scar. Good blood supply was present at the pedicle and its entire area. The graft was secured upon the scar with interrupted No. 000 catgut sutures. The skin edges of the head were undermined and approximated with interrupted silk sutures. Pressure dressings were applied. Sulfathiazole was given by mouth for five days as a prophylactic measure. Dressings and sutures were removed on the seventh day and the patient was discharged on the eleventh day with the wound healed and the defect completely covered.

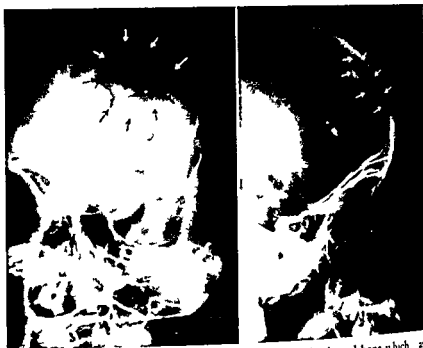


Fig. 481 (Case IV, J. A.)—Postoperative Area of the frontal bone which was leprosed and fragmented removed. Fragments of the lead bullet also removed. Oil-soluble fragments of the bullet deep in the brain substance are left in situ.

plastic measure. Dressings and sutures were removed on the seventh day and the patient was discharged on the eleventh day with the wound healed and the defect completely covered.

Case V—J. K., a white man aged forty-seven years while in line of duty operating a locomotive engine and looking out of the cab window was struck on the left side of his head and ear by a large door swinging from a refrigerator railroad box car of a passing train on November 18, 1943, rendering him unconscious. He was brought to the Accident Ward of the Methodist Hospital in a semiconscious state. There were four separate lacerations of the tragus of the left ear and a large jagged laceration over the left mastoid area. The entire area had a blue, purplish discoloration and blood was oozing from the left auditory canal. The temperature was 97°F, pulse 88 respirations and blood pressure 110/80. All reflexes were normal. A diagnosis of compound comminuted fracture of the left mastoid region was made by palpating the open wound with a sterilized finger. A sterile dressing was applied to the wound.

Shortly after admission to the patient regained consciousness and in about ten

hour his temperature was normal and his general condition seemed satisfactory. Roentgenograms were taken and the patient was operated upon. The left side of the head was shaved and the area around the wound cleaned with soap water ether and alcohol. The external auditory canal was swabbed clean with sterile dry cotton applicators and a small pledget of dry cotton left in the canal. Block excision of the wound over the left mastoid region was performed and four spicules of bone removed. The wound was packed open with sterile petrolatum gauze and the peripheral parts of the wound approximated loosely with interrupted silk sutures. Dry sterile dressings and a mastoid type bandage were applied. The lacerations of the tragus were approximated loosely with interrupted silk sutures and a sterile dressing applied. The external auditory canal was swabbed clean daily the sutures of the left tragus were removed on the seventh day and the dressing sutures and petrolatum gauze packing removed from the left mastoid region on the tenth day. Practically all of the wound had healed by primary intention and the area in which the packing had been removed was swabbed clean with aqueous azochloramid solution sterile petrolatum gauze dry dressings and a mastoid type bandage were applied. Weekly dressings were made thereafter and the remainder of the wound healed completely by secondary intention. The patient was discharged on the twenty fifth day and his only complaint was that he did not have any sensation in the region of the tragus of his left ear.

CASE VI—M S a white man aged fifty-eight years was thrown about 10 yards by a blow-out caused by inflating a flat tire on his truck on February 3 1944. The patient was brought to the Accident Ward of the Methodist Hospital



Fig 48 (Case VI M S)—Comminuted fracture of the left maxilla and vomer bone. Linear fracture through the right frontal sinus the right occipital region and the base of the skull.

in a state of unconsciousness. There was a large jagged laceration over the bridge of his nose which extended onto the left side of his face over the left maxillary sinus region. The entire left side of the face was contused and discolored with periorbital ecchymosis and free bleeding from both nostrils. Both bones of the left forearm were fractured at the middle third. The temperature was 96° F pulse rate 76 respirations 16 blood pressure 60/30. The left forearm was splinted and a sterile dressing applied to the face. Two units of blood

plasma are given intravenously. The patient regained consciousness about ten minutes after admission. His general condition improved rapidly and thus the initial temperature was normal and blood pressure 120/72.

The patient was sent to the x-ray room (Fig. 48) and then to the operating room. Under intra-arterial lumbar pentothal anesthesia the wound was cleaned in the following manner. In examining the wound with a sterile gloved finger three detached fragments of bone of the left nasal bone were found. Culture taken from the nasal cavity showed Staphylococcus aureus in pure growth. Although the left side of the hard palate was palpable there was no perforation into the oral cavity. However there was communication of the wound with the left nostril. The entire wound was excised and the three fragments of bone were removed. The nasal cavity was packed with sterile petrolatum gauze and the periphery of the wound including the area over the nose was approximated loosely with interrupted silk sutures. Each nostril was swilled clean and one strip of sterile petrolatum gauze inserted. Roentgenograms revealed comminuted fracture of the left nasal bone and a right frontal fracture through the right frontal sinus. Right maxillary region and the base of the skull (Fig. 48) and a comminuted displaced fracture of the middle third of the bones of the left forearm.

The patient in the left forearm was lifted in place and open reduction was accomplished at a later date. The packing from the nostril was removed twenty-four hours later. The face wound was redressed on the fifteenth day. All dressings, dressings and packs were removed. Culture of the wound showed Staphylococcus aureus in the streptococcus and Bacillus. The wound had healed by the twentieth day. On the twenty-first day one small strip of sterile vaseline gauze was placed over the wound. The area was gently irrigated with aq. azoicilran and a small strip of sterile petrolatum gauze placed over the wound. The wound was dry dressings applied. The wound was dressed every day and completely healed on the twenty-fifth postoperative day.

COMMENT

1 Many neurosurgeons make distinctions between wounds of the scalp which have slight depression of the bone without gross contamination and those which have extensive depression of the bone with or without gross contamination. We on the other hand treat all penetrating wounds of the skull or long bones as potentially infected wounds regardless of the gross appearance or the time of injury. We naturally prefer to operate within the golden six hours from the time of the infliction of the wound. The damage done to the brain at the time of injury is irreparable except by nature's own processes, and operations should only be undertaken for the prevention of sepsis or for the relief of compression by depressed bone hemorrhage or abscess.

2 Preferably no patient is operated upon until recovery from surgical shock; however if the patient does not respond to the treatment for shock then he is operated upon and shock treated concomitantly with definitive treatment of the major injuries.

3 In this type of wound the head injury takes precedence over injuries of any other region of the body. That is first aid dressing is applied to other parts of the body and definitive treatment is given only if the patient's condition is satisfactory in regard to his head injuries.

4 Our guiding principle in the treatment of all compound fractures of the extremities involving joints and penetrating wounds of the joints is the closure of the joint capsule without drainage and the remainder of the wound is picked wide open with sterile petrolatum gauze. Prior to the closure of the capsule all gross infected material is removed and the joint cavity is gently irrigated with a small amount of ether and physiological saline solution. The jagged bone fragments or cartilage are curetted or chiseled out. By this process hemorrhage, effusion, the escape of synovial fluid and fistula formation are kept at a minimum. Similarly, the closure of the dura mater should be performed in order to prevent the formation of hernia cerebri or fungus cerebrospinal fistulas and intracranial aerocele.

5 Horrax⁷ in World War I and Money and Nelson⁸ in World War II working farther behind the lines preferred leaving the skin flaps open. This was done in order to obtain better drainage when there was more widespread infection or following the formation of discharging sinuses many days following the first operation. If the method of leaving skin flaps open is satisfactory in complicated cases as reported by Horrax, Money and Nelson it would appear reasonable to use this method with a suitable definite type of dressing and routine in compound injuries of the head and face *prior to the onset* of complications.

SUMMARY

1 The management of compound injuries of the head region has been outlined.

2 A type of dressing for compound fractures of the skull has been described.

3 Lacerations of the scalp in these types of injuries are usually jagged in character and the surrounding skin is usually widely contused and undermined.

4 Compound fractures of the skull are always comminuted. The inner table of the skull is always more severely damaged than the outer table. Although the outer table may not seem to be badly damaged or fractured, the inner table usually splinters like glass with fragments becoming detached from it.

5 Six cases have been presented in detail which demonstrate not only the various types of wounds but also the extent of the injuries. All of the patients had compound comminuted depressed fracture of the skull with the degree of damage as follows: Case I without penetration of the dura; Case II without penetration of the dura and an associated fracture of the extremities; Case III with penetration of the dura and hemorrhage; Case IV with penetration of the dura, hemorrhage, damage to the brain tissue with indriven bone fragments, hair and foreign metal; Case V involving the left mastoid region, middle ear and the external auditory canal; Case VI demonstrating

craniofacial wounds and associated injury to the extremities. In this case there was a linear fracture through the right frontal sinus, the right occipital region and the base of the skull comminuted fracture of the vomer bone compound comminuted fracture of the left maxilla and a comminuted fracture of both bones of the left forearm.

(The end results have been recorded)

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PREOPERATIVE AND POSTOPERATIVE CARE OF PATIENTS WITH LESIONS OF THE STOMACH AND DUODENUM

HAROLD A ZINTEL MD *

ALTHOUGH there have been many improvements in operative technics during the past fifteen years the marked reduction in surgical mortality observed in this same period has been due largely to improvements in preoperative and postoperative care. In no type of surgery is this more true than in operations on the stomach and duodenum. Few major surgical procedures require as thorough preparation and after care as do operations on the upper gastro intestinal tract. Physiological disturbances and the resultant biochemical disturbances secondary to lesions of the stomach and duodenum are now fairly well understood.

PREOPERATIVE EVALUATION AND CARE

Prior to operation the patient must be evaluated in the following respects (1) the presence or absence of obstruction (2) the state of hydration (3) the electrolyte balance (4) the body stores of protein (5) the total daily caloric intake (6) the vitamin intake and (7) the presence or absence of anemia. In addition to the routine blood count hemoglobin determination urinalysis and blood Wassermann reaction determinations of the serum protein chloride and carbon dioxide are indicated. If these are found to be abnormal they should be repeated at least every second day during the preoperative period until they have reached a satisfactory level. An x ray examination of the stomach and duodenum should be done if it has not been done during the previous few weeks.

Obstruction—In the presence of pyloric obstruction the stomach is dilated and the stomach wall is often edematous. Marked edema interferes with the operative procedures and leads to a greater morbidity and mortality. Edema results from one or more of the following (1) trauma resulting from the powerful gastric contractions as the stomach attempts to empty itself (2) secondary infection superimposed on a lesion of the duodenum and stomach (3) an inflammatory obstructive process (4) hypoproteinemia and (5) vitamin B₁ deficiency.

The first two of the factors which contribute to this edema may be overcome to a considerable degree by the insertion of a Levin

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tube through the nasal passages into the stomach and the application of continuous suction drainage by the method of Wangenstein and Paine¹ An alternate method of keeping the stomach empty is by periodic gastric lavage When accumulations of undigested food plug the ordinary nasal catheter the old fashioned stomach tube of large caliber must be used It is best to withhold all food by mouth for from two to five days after the institution of suction drainage and to permit the ingestion of readily digestible foodstuffs only when pyloric patency is established In the face of obstruction and gastric retention the stomach contracts in an effort to expel its contents It is thought that such action aggravates the inflammatory reaction and increases edema especially if infection is already present Continuous aspiration by relieving the burden on the gastric musculature by reducing the trauma to the lesion itself and by removing stagnant bacteria containing gastric contents decreases the amount of edema of the gastric wall and may decrease secondary infection The retention of large quantities of food favors the development of infection When in carcinoma of the stomach a complete absence of hydrochloric acid—the true acidity of Keefer and Bloomfield—is demonstrated there is also nearly always an absence of pepsin and rennin, and the gastric contents become an excellent culture medium for bacteria which have been ingested The removal of this culture medium reduces the possibility of secondary infection

State of Hydration—Patients with lesions of the stomach and duodenum are often dehydrated Decreased turgor of the skin sunken facial expression dryness of the skin and tongue increased thirst and low urinary output are signs indicative of dehydration Coller and Maddock² report that when these signs are present there is dehydration equivalent to at least 6 per cent of the body weight In order to overcome dehydration therefore in addition to the daily requirement of fluid 60 cc per kilogram or 4800 cc for a man of 80 kilograms would be the calculated amount of fluid that should be given A word of caution is necessary in replacing fluids in elderly patients, patients with cardiac deficiencies or patients with low serum protein levels It is advisable to give the calculated amount of fluid in addition to the daily requirement over a period of two or three days The increased fluid intake is maintained until the daily urine output is between 1000 and 1500 cc

Electrolyte Balance—Lesions of the upper gastro-intestinal tract frequently cause vomiting Vomiting contributes not only to dehydration but also causes a depletion of the serum chloride and an elevation of the serum carbon dioxide combining power Chloride deficits are overcome by the administration of sodium chloride by vein on the basis of 0.5 gm of sodium chloride per kilogram of body weight for each 100 mg which the serum chloride level is depleted When the chlorides are expressed in milli equivalents they are restored by admin

istering 13.5 mg of sodium chloride per pound of body weight for each milli equivalent the serum chlorides are depressed below the normal level. When sodium chloride and fluid are administered in adequate amounts the carbon dioxide value if elevated usually returns promptly to normal. For the patient with severe alkalosis and a high carbon dioxide combining power who does not respond to adequate fluid and sodium chloride it may be necessary to administer a 2 per cent ammonium chloride solution intravenously as suggested by Zintel Rhoads and Ravdin⁴ if the alkalosis nephrosis described by Nicol⁵ and others is to be avoided.

Protein Stores—Inability to retain and digest an ordinary well balanced diet leads the patient with a lesion of the upper gastrointestinal tract to adopt an easily digested high carbohydrate diet. Thus the patient when admitted to the hospital may be poorly nourished and often is hypoproteinemic. An apparently normal serum protein level on admission may be misleading because of coexisting dehydration and reduction of circulatory volume. The low serum protein level may become apparent only when dehydration has been overcome. Occasionally edema develops following the administration of intravenous solutions. Fluids should be administered cautiously in the presence of dehydration and suspected hypoproteinemia. The edema so produced is a generalized edema. Meckel, Barden and Ravdin⁶ first demonstrated that edema secondary to hypoproteinemia causes a marked delay in gastric emptying time and of the stomach to cecum time.

Barden, Ravdin and Frazier⁷ have shown that the edema of hypoproteinemia may be sufficient to produce nonfunction of a technically satisfactory gastro enterostomy. Thompson, Ravdin and Frank⁸ first showed hypoproteinemia to be a cause of wound disruption. In their experimental series 72 per cent of the hypoproteinemic animals either had wound disruptions or failed to heal. Hartzell, Winfield and Irvin⁹ in a study of wound disruption found that in nearly every instance the patients had a vitamin C deficiency or hypoproteinemia or both.

The most rapid method of overcoming hypoproteinemia is by the use of plasma. Usually 250 to 500 cc per day will bring about a satisfactory elevation of the serum protein level. Occasionally larger amounts are needed. Intravenous amino acids are proving to be an aid in the treatment of protein deficiency. In the absence of a partial or complete obstruction protein digests may be administered by stomach or duodenal catheter.¹⁰

Caloric Intake—Every attempt should be made to increase the total caloric intake if there is evidence of malnutrition. When the gastrointestinal tract is patent the oral route is the one that should be used. In the presence of obstruction however the oral route is not available and therefore intravenous administration must be resorted to. Patients receiving plasma, blood or amino acids should also receive intravenous glucose in order to elevate their daily caloric intake.

It must be remembered that proteins given to a hypoproteinemc patient are utilized for energy requirements as well as for building of the serum proteins as long as the total caloric intake does not equal the total daily caloric requirements of the patient.

Vitamins—Although patients with duodenal and gastric lesions may have other vitamin deficiencies deficiencies of vitamin C and the members of the B complex should be mentioned specifically. Patients with carcinoma of the stomach and patients with ulcer of the stomach or duodenum often have very low vitamin C levels. It is especially important that a vitamin C deficiency be overcome preoperatively because there is a definite decrease in the plasma vitamin C level following any operative procedure as demonstrated by Bartlett Jones and Ryan.¹¹ If primary wound healing is to be obtained there must be adequate vitamin C in the body.

Partial or complete obstruction of the upper gastro intestinal tract leads to a deficiency of vitamins especially the members of the B complex. If a vitamin B deficiency with its associated edema and atony of the gastro intestinal tract is to be avoided thiamine hydrochloride and riboflavin should be administered parenterally.

A patient being prepared for gastric or duodenal surgery may well receive 100 mg. of vitamin C, 75 mg. of nicotinic acid 25 mg. of thiamine 5 mg. of riboflavin and 5 mg. of vitamin K. There is not a specific indication for vitamin K in all patients with lesions of the stomach and duodenum. However when there is a moderate hypoproteinememia or if the gastric drainage is blood tinged it is wise to administer it.

Anemia—Except under unusual circumstances patients should not be operated upon unless the hemoglobin level is between 40 and 80 per cent. Those who have hemoglobin levels below 40 per cent should receive blood transfusions prior to operation. A suitable liver extract should be administered if the blood picture resembles that in primary pernicious anemia. If bank blood is available sufficient blood should be ready for immediate use during the operative and the immediate postoperative period. In the absence of a blood bank a suitable number of donors should be available during this period. Anemic patients do not stand operations well and they seem more prone to go into shock than are patients with normal hemoglobin levels.

GASTRO ENTEROSTOMY OR SUBTOTAL GASTRIC RESECTION

In the course of diagnosis of patients destined to have a gastroenterostomy or a subtotal gastric resection an x-ray examination is made of the gastro intestinal tract. If there is evidence of partial or complete obstruction continuous suction drainage of the stomach is instituted. Dehydration if present is treated with intravenous fluids with added vitamin preparations to insure adequate body stores of the vitamins. Determination of the serum chloride carbon dioxide protein

and blood hemoglobin levels are made at the time of admission and at forty eight to seventy two hour intervals during the preoperative and immediate postoperative periods. Fluids sodium chloride vitamins plasma and blood are given as necessary to restore and maintain normal physiological balance.

Frequently after two to five days of suction drainage the edema of the stomach is decreased sufficiently to allow food to pass through the pylorus. Small amounts of liquid or low residue foods are then

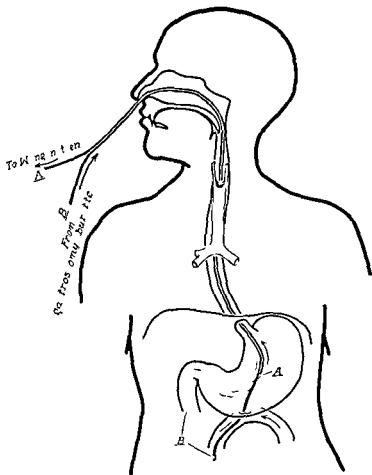


Fig 483—Position of the Abbott Rawson tube and its outlets at completion of operation

allowed. The gastric residue may be determined by aspirating the stomach each morning and each night and measuring the amount recovered. If it is evident that the gastric or duodenal passageway is not patent suction drainage is again instituted. Such a regimen requires five to ten days for adequate preparation. Graham¹ advised ten to fourteen days of preparation. Provision is made for adequate blood or plasma to be used during the operative and postoperative periods.

Diet Following Subtotal Gastrectomy or Gastroenterostomy—Previously following operations on the stomach patients often received no nourishment by mouth from four to seven days and occasionally longer in cases which presented special nutritional and technical difficulties. The advent of the Abbott Rawson tube¹³ (Figs 483 and 484) has facilitated immediate postoperative feeding. In this manner nutrient material is administered during the first few days of the postoperative



Fig. 484—Bisgard's method of exteriorizing the tube through a gastrostomy opening in the abdominal wall.

period when the demand for nutrient material for the repair of the body is believed to be the greatest. By means of this double lumen indwelling tube continuous suction drainage can be maintained in the stomach in the region of the surgical reconstruction while nutrient material is fed by slow drip into the normal small bowel below the area operated upon. Decompression of the stomach prevents excessive tension on the newly placed suture lines which might lead to leakage and the spilling of gastric contents into the peritoneal cavity.

Figure 483 shows the position of the tube and its outlets at the completion of operation. The tip of the tube which is inserted by the naso esophageal route into the stomach before or during operation is manipulated through the stoma into the small bowel when the stoma is completed. The more recent innovation of Bisgard¹⁴ which consists of exteriorizing the tube through a gastrostomy opening in the abdominal wall (Fig 484) presents advantages over the naso esophageal route. This technic relieves the patient of a great deal of discomfort, reduces the possibility of respiratory infections and eliminates the possibility of laryngeal edema¹⁵ which has been reported with in-

TABLE 1—JEJUNOSTOMY FEEDING

Vitamin feeding—added to the regular feedings once daily

	Carb Gm	Prot Gm	Fat Gm	Calories
<div> <div> 1½ cup orange juice 1 egg 3 drops viosterol 5 drops haliver oil 1 Harris yeast tablet </div> </div>	10	6	6	170
<i>Jejunal Feeding</i>				
1½ qts milk	75	45	52.5	
1 pt cream	20	15	100	
¾ cup sugar	150			
1 cup flour	90	13	15	
½ cup peptone		80		
	335	153	154	3438
Ringer's solution				1000 cc
or				
Water				1000 cc
plus 1 tsp salt				

Method—Dissolve sugar in water. Add peptone. After both peptone and sugar have been dissolved thoroughly in the water, heat for several minutes. Mix flour with part of the milk to make a smooth paste. Mix peptone solution with flour and milk. Bring mixture to a boil quickly over hot flame. Do not allow to boil. Stir vigorously, keeping at a subboiling point until it thickens to the consistency of a thick or thin flour paste. Strain, cool, keep in refrigerator.

dwelling naso esophageal catheters. Gastrostomy wounds have healed rapidly following removal of the tube on the fourteenth postoperative day. Drainage usually ceased in twenty-four to forty-eight hours.

Postoperative feeding is first by vein, then by jejunal tube and finally by mouth. On the day of operation, nutrition is entirely or almost entirely by vein in the form of intravenous 5 per cent glucose and 5 per cent glucose in saline solution. As early as eight or ten hours after operation, sterile 5 per cent glucose solution may be administered by slow drip into the Abbott-Rawson tube. On the first postoperative day, feedings (Table 1) containing approximately one

calorie per cubic centimeter of fluid are started. In the next few days the jejunostomy feedings are increased as tolerated by the patient and at the same time the intravenous fluids are gradually reduced. On the fourth postoperative day water is allowed at the rate of 1 ounce an hour and suction aspiration of the stomach is discontinued on alternate hours. Thereafter suction is discontinued as tolerated by the patient. A fruit juice gelatin mixture (Table 2) is started on the fifth or sixth day at the rate of 2 ounces every second hour. On the following day the amount is increased to 4 ounces and the fruit juice gelatin mixture is alternated with an equal amount of oatmeal gruel (Table 3) every second hour. The amounts are then increased to 6 ounces

TABLE 2—(Fruit Juice and Gruel Mixtures)

<i>Fruit Juice and Gelatin Mixture</i>	Ounces	Grams	Calories Per Ounce
Gelatin	1	20	
Lactose	4	10	
Juice of one orange			
Water	37	1000	170
<i>Gruel Mixture</i>			
Cereal gruel (oatmeal)			
Barley or cornmeal	16	90	
Milk	14	40	
Lactose	4	10	310

per feeding. Usually on the eleventh day 3 ounces of cereal one soft poached egg custard or gelatin is added to each gruel feeding. On the thirteenth day a semisoft diet is administered. Vitamins are at first administered intravenously then by jejunostomy feeding and finally by mouth.

The accompanying graph (Fig. 48) shows such a feeding regimen as applied to patient S.V. following a subtotal gastric resection. It must be remembered that the feeding program outlined serves only as a guide. Some patients are able to progress more rapidly and still others cannot tolerate oral feeding at the rate outlined. Each patient is an individual problem. Patient S.V. received an average of 3450 calories per day for the day of operation and the first ten postoperative days. The serum protein level, the hemoglobin level and the patient's weight were all maintained at the preoperative levels in spite of extensive surgery of the stomach and duodenum. Mulholland and his associates¹⁰ have shown that when a high caloric intake is not maintained the hemoglobin level, the serum protein level and the patient's weight all show a progressive decrease. They further believe that the maintenance of a high caloric intake will reduce postoperative morbidity and mortality. Such a program meets all of the factors which must be accounted for in the proper postoperative management of

patients who have had gastric and duodenal surgery (1) fluid balance (2) electrolyte intake (3) daily caloric intake (4) vitamin intake (5) protein intake

Occasionally following gastric resection the distressing symptoms of postprandial distention or quick filling of the jejunum are encountered. These symptoms are (1) feeling of excessive fullness (2) abdominal cramps (3) profuse perspiration (4) palpitation and (5) weakness. When these patients return for follow up visits several weeks after operation they may in addition complain of a failure to

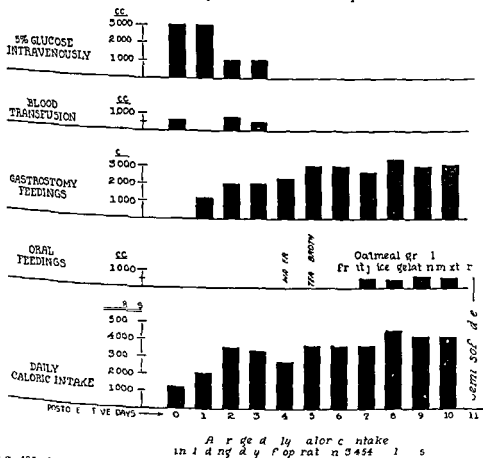


Fig 485 Fluid and caloric intake of patient (S V) following subtotal gastric resection

gain weight in spite of a good appetite. This is easily understood when one realizes that their capacity for food has been reduced by removal of a part of the stomach. Their appetite is satisfied by the small amount of food necessary to distend the gastric stump and this amount of food ingested three times a day is not sufficient to meet their daily caloric requirements. The distressing symptoms are easily overcome by (1) returning to more frequent feedings (2) giving drier foods such as cooked bland cereals, toast, crackers, steamed rice and baked potatoes instead of the more liquid foods (3) having the patient lie

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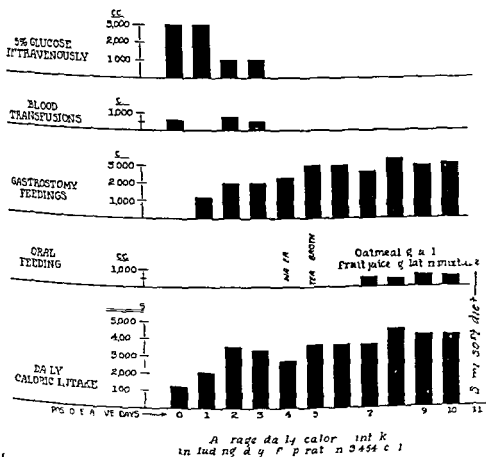


Fig 4a3—Fluid and caloric intake of patient (S V) following subtotal gastric resection

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down for fifteen to twenty minutes immediately after each feeding and (4) restricting of fluid intake to the periods between feedings.

It is seldom necessary to give hydrochloric acid following operation. In ulcer cases an achlorhydria or hypochlorhydria is highly desirable. In crises operated upon for carcinoma there is often no pepsin to be activated by hydrochloric acid but small doses of hydrochloric acid may sometimes give symptomatic improvement especially if there is a tendency toward diarrhea.

TOTAL GASTRECTOMY

Following a total gastrectomy patients require special consideration. At the time of operation an Abbott Rawson tube may be inserted beyond the area of anastomosis by the naso-esophageal route or a single lumen tube may be inserted in the jejunum by jejunostomy. The intravenous fluids and jejunostomy feedings are begun as outlined for subtotal gastrectomy. The jejunostomy feedings are continued for a longer period of time. Usually nothing is administered by mouth until the seventh postoperative day. At this time water is begun by mouth at the rate of 1 ounce an hour. Between the tenth and twelfth day jejunostomy feedings are given by mouth at a rate not exceeding 50 cc per hour or 720 cc in twenty-four hours. At the end of two weeks small feedings of bland foods such as gelatin, cooked cereals and custards are given in 2 ounce portions every two hours to replace the liquid formula feedings. When these feedings are well tolerated the amount is gradually increased so that usually at the end of three weeks six feedings of a semisoft diet are ingested each day.

Symptoms of primary pernicious anemia have been reported following subtotal gastrectomy and therefore it is essential that anti-pernicious anemia factors be administered. There apparently is no indication for hydrochloric acid since there is no pepsin to be activated. Secondary anemia has been reported following complete removal of the stomach. To combat this complication iron in the form of a stable ferrous sulfate solution is administered. The supplemental vitamins are best continued over a period of weeks or months. The six feedings regimen must be continued for several months postoperatively and then the diet may be slowly augmented until a more normal diet is tolerated.

POSTOPERATIVE COMPLICATIONS

Pulmonary Complications—Important among the complications which may follow operations on the stomach and duodenum are pneumonia and atelectasis. Atelectasis may occur during the first twenty-four hour period after operation. Symptoms are those of rapid shallow respirations and moderate to severe cyanosis. Physical examination shows evidences of a decreased aeration usually at the bases with or without thick coarse rales. Partial lung collapse is best treated by carbon dioxide inhalations for two to three minutes every hour. If

the patient has difficulty in coughing up thick mucus the trachea should be aspirated by means of a small stiff rubber catheter as has been described by Haight and Ransom.¹⁷ Blind tracheal aspiration is a simple procedure which is easily done by the intern and it is furthermore very effective. More advanced cases and those with established atelectasis should have bronchoscopic aspiration.

Hemorrhage—With continuous postoperative suction drainage of the stomach the patient usually drains 100 to 200 cc of old dark blood during the first six hours. If this drainage continues for more than six or eight hours or if the drainage becomes bright red in color reoperation may have to be considered. However in most such patients bleeding will stop if supportive treatment is provided. The patient should receive blood by slow drip transfusion and blood should be available for emergency use. A constant vigil should be kept for symptoms of shock. If operation is necessary the mucosal aspect of the stoma should be inspected and the bleeding point closed by suture.

Leakage and Peritonitis—If continuous suction aspiration is used after operation leakage of the stoma suture lines seldom occurs. Leakage may result from an insecurely closed duodenal stump. If at the end of five days the patient continues to have an elevation of temperature and a high pulse rate leakage should be suspected. Either generalized peritonitis or a localized abscess may develop. Sometimes a duodenal fistula develops. Such a fistula may appear about the eighth to tenth day with a rather copious drainage of moderately clear fluid. Constant suction as described by Lahey¹⁸ is the best method of treatment in this condition. If the material obtained by aspiration is excessive in amount it should if possible be re-fed into the jejunum to prevent severe depletion of electrolytes and enzymes. The severe irritation of the skin caused by the small bowel content may be treated with 10 per cent aluminum powder in a base of equal parts of lanolin and zinc oxide ointment or by a mixture of Fuller's earth and mineral oil.

Nonfunction of Newly Formed Stoma—Nonfunction of the stoma may be due to the edema of hypoproteinemia as demonstrated by Barden Ravidin and Frazier.⁷ The edema of hypoproteinemia is further accentuated by edema subsequent to the trauma of the operative procedure and possibly by mild transient infection. Patency of the stoma is observed as soon as the serum protein deficiency is overcome by plasma and blood transfusions.

An indwelling double lumen Abbott Rawson tube (Fig. 483) inserted at the time of operation is a great aid in the treatment of delayed function of an operative stoma. Such a tube makes possible continuous or intermittent aspiration of the stomach while nutrition is maintained through the second and longer lumen which terminates in the jejunum below the stoma. A tube of this type usually eliminates the possible necessity of a secondary operation. The tube is left in place until adequate function of the stoma is demonstrated.

In the event that an Abbott Rawson tube has not been used failure of function must be treated by continuous or intermittent aspiration of the stomach by a Levin or similar type of tube. Hypoproteinemia should be vigorously combated with multiple transfusions of blood or plasma. The stoma usually functions after four to six days of aspiration. If at the end of two weeks failure of the stoma to function is demonstrated by x-ray examination a secondary operation must be considered. At this time some provision should be made for jejunal feedings.

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HYPERTENSION IN A CASE OF HYPERTHYROIDISM ASSOCIATED WITH ACROMEGALY

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PATIENTS suffering from hyperfunction of more than one of the glands of internal secretion present a complex clinical problem. The greater our experience is in this field the more difficult it becomes to analyze the symptoms and physical findings to determine the number of these glands that are contributing to the clinical picture presented by such patients. After we have determined the glands in which there is a disturbance in function their interrelationship and interdependency is so interwoven in some cases that considerable study is necessary before any decision is made as to the proper treatment. I wish briefly to consider the problem presented by the patient suffering from hyperthyroidism in association with acromegaly and describe such a case in detail. In addition this patient had hypertension contrary to the usual finding of a low blood pressure in acromegaly. In the absence of any etiological factor the hypertension was diagnosed as essential. Whether or not an obscure disturbance in the function of the adrenal gland was the cause of the hypertension is an interesting question.

We have known for some years that enlargement and increased function of the thyroid gland frequently occurred in acromegaly. Our first knowledge as to why this occurred was acquired in 1929 when Loeb and Bassett¹ isolated the thyrotropic hormone from the anterior lobe of the pituitary and produced enlargement and increased function of the thyroid gland by injecting the substance in the lower animal. It has also been observed clinically that not infrequently patients receiving this hormone in injections of the anterior pituitary extract for a deficiency of pituitary function have developed symptoms of hyperthyroidism.

Davis carefully analyzed the status of the thyroid gland in 166 cases of acromegaly which occurred at the Mayo Clinic. In eighty six cases the thyroid gland was described as enlarged. Of these eighty six cases adenomas were found in fifty three the gland was palpable in twenty four was regarded as enlarged in seven and in two cases a diffuse colloid goiter was found. The adenomas reached large proportions in some patients and caused tracheal compression. The basal metabolism varied but was higher than normal in 116 cases. We recognize that the course of a case of acromegaly is punctuated by periods of exacerbation and remissions. The clinical findings par

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hypertensive changes in the eye grounds the kidney function was good and arterio sclerosis had not progressed beyond the degree it should find in woman of her age. There was no enlargement of the thyroid gland at the time. The diagnosis was (1) acromegaly (2) ataxia due to x-ray treatment and (3) essential hypertension.

The patient remained in the hospital five days and by that time she had had a hypoglycemic attack. The roentgenologist continued x-ray therapy on the parathyroids and all other treatments over the following year for the hyperthyroidism. She was readmitted to the hospital in February, 1939. In the interval there was a gradual increase in the size of the tongue which caused marked thickening of the speech. There were no other changes of any significance. The blood pressure was 110/110. She remained in the hospital for one month while receiving a series of x-ray treatments. This precaution was taken because of the ataxia which was thought to have developed from the previous x-ray treatments.

During the succeeding fifteen months there was a considerable improvement in her x-ray therapy. The acromegaly apparently was at a standstill and the tongue had returned in size so that the patient's speech became clear. She had periods of increase in blood pressure accompanied by nervousness. In August, 1940, she was operated upon for a benign lesion of the right breast.

In May, 1941, although the acromegaly had not made further progress, the clinical symptoms of hyperthyroidism developed and there was a progressive loss of weight. At this time moderate nodular enlargement of the thyroid gland was noted. The patient experienced periods of lassitude and began to have choking and disturbances more pronounced when he was in the recumbent position. In November, 1941, she began to suffer from severe headache which persisted becoming more constant until her admission to the hospital January 5, 1944. A careful checkup revealed that there was no progressive changes in the acromegaly. The blood pressure was 210/130. Under sodium amytal the blood pressure fell from this figure to 138/118 showing that the diastolic pressure was somewhat fixed.

Roentgen study of the skull showed slight increase in size of the sella since the time of the previous examination two and one half years ago. There was also more depression of the floor with encroachment on the sphenoid sinuses. The thickening of the external vault had not increased appreciably. The previous examination X-ray of the chest showed that there were no localized areas in the right lower cerebral region probably in the territory of the third. The trachea was not appreciably compressed or displaced. Examination of the thyroid showed the nodular goiter more marked on the right than the left, extending well below the sternum on both sides. Slight pressure on either produced marked local tracheal signs.

Laryngoscopic examination was done with a great deal of difficulty and showed marked thickening of the arytenoid area, the arytenoid region being greater than the right. This swelling was soft and firm to touch, the vocal cords of the larynx and vocal cords. The electrocardiogram was essentially normal. Blood and urine analyses were negative. The blood sugar was 17 mg. per 100 cc. and the basal metabolic rate plus 30. The 17 ketosteroids were 11 mg. per 24 hours, to be 18 mg. The patient was a relatively normal and is in keeping with the relative intensity of the acromegaly at this time.

The patient was placed on the routine preoperative preparation for thyroidectomy. She improved clinically but her basal metabolic rate taken ten days later was plus 36. On January 21, seventeen days after admission under tracheal anesthesia, I removed in toto the right lobe of the thyroid. This was rendered well into the mediastinum. The pathological diagnosis of the tissue removed was toxic nodular goiter with almost complete involution.

The patient responded satisfactorily after operation and the headaches were relieved immediately. The heart sounds were of good quality at all times and there were no signs of a failing cardiovascular system. The blood pressure fell and was maintained most of the time between 164/104 and 170/110. On several occasions 1 cc of adrenal cortical extract was given when the pressure fell below 160 to prevent an adrenal insufficiency from developing. The patient left the hospital eight days after operation having made an uneventful recovery with instructions to return to the hospital to have the other lobe removed in six weeks. In the interval between operations the symptoms of hyperthyroidism had almost completely disappeared, the headaches had been relieved and she gained 12 pounds in weight. She also noted relief from dyspnea and obstructive disturbances when resting. The blood pressure had returned to the preoperative level.

After several days rest in the hospital the left lobe was removed on March 21, 1944. This lobe also extended well down in the mediastinum. All but the superior pole of this lobe was excised. The postoperative course was identical with that which followed the first operation even to the use of cortical extract several times for the fall in blood pressure.

Follow up studies revealed that the clinical picture of hyperthyroidism entirely disappeared, the obstructive symptoms were relieved, there was no recurrence of the headaches and the sensation of pressure at the back of the neck which she thought was due to the hypertension was gone. Examination eight months after operation revealed still further improvement. At this time the patient noticed a recession of the calcium deposits in her hands. There was definite return of growth of hair on her scalp while the excessive hairy growth on her arms and legs had receded. She was able to breathe more freely and slept with ease. There has been no increase in the prominence of the eyes. Marine and Rosen³ found that exophthalmos may become more pronounced following resection of the thyroid gland. Davis suggested that this may occur in a patient who had a persistently increased amount of thyrotropic hormones.

The operation in this case was performed in stages since the patient was regarded as a poor surgical risk. The course after both operations I believe justified the more conservative method. The acromegaly presumably was arrested before the time of thyroidectomy. The early results are most encouraging but this improved condition is not regarded as the final outcome and a later report may be necessary as experience has shown that in some instances it takes several years before we can determine the effect thyroidectomy will have on the course of the acromegaly.

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RADICAL PANCREATODUODENAL RESECTION FOR ADENOCARCINOMA OF THE HEAD OF THE PANCREAS

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THE development by Whipple¹ Brunschwig and others of a surgical technic for the radical removal of carcinoma of the head of the pancreas necessitates an earlier diagnosis so that more and more cases may be found operable at laparotomy. Until this development, it was good judgment to observe a case of painless jaundice for six weeks to two months with the hope that it would prove to be catarrhal jaundice as surgery had so little to offer. Today, however, we know that this delay may be sufficient for an operable lesion to grow into an inoperable one. With this in mind, Tables 1 and 2 have been constructed to aid in the differential diagnosis of surgical and nonsurgical jaundice of the hepatocellular variety. The diagnosis of hemolytic jaundice is usually sufficiently clear and it is not included in the tables. The papers of Waugh,² Snell,⁴ Nadler and Butler,⁵ Olwin,⁶ Holbrook,⁷ Foote and Carr,⁸ and especially that of Meyer and Steinmann⁹ have been freely drawn upon in formulating the tables.

Space does not permit a detailed discussion of the differential diagnosis as outlined in the tables. It is obvious that a clear cut differentiation cannot be made on any one point; rather, the diagnosis must be made on the composite picture. This picture is made up of a complete survey of the patient at frequently repeated intervals. One must also take into account the fact that late in the disease obstructive jaundice causes considerable liver damage and that therefore the findings in hepatocellular and obstructive jaundice tend to be similar.

The Graham-Cole test generally, as in our case, simply shows non-visualization of the gallbladder. Foote and Carr⁸ have developed a technic which should be of great aid in differentiating hepatocellular jaundice from surgical jaundice. Their technic consists in giving three 750 mg. doses of iodeikon (tetraiodophthalein sodium) in 1000 cc. of 10 per cent glucose at twenty-four hour intervals. Pictures are ever-
case were taken twenty hours and again forty-eight hours after administration of the last dose of dye. In this way the extrahepatic biliary system is visible if there is an obstruction in the common duct but it is not visible if there is an intrahepatic block.

If a definite diagnosis cannot be made, then surgical exploration is indicated. If the lesion is not surgical, the harm to the patient can be kept at a minimum with adequate preoperative preparation and continuous spinal anesthesia.

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REPORT OF A CASE

History.—M B a woman aged fifty two years, was admitted to the Taylor Hospital on October 1st 1943 under the care of Dr Richard Owen. Her past medical history was insignificant except for an attack of jaundice in childhood which threatened her life. Since then she had been well until a year before admission at which time she began to complain of vague indigestion and gas pains. These symptoms became more annoying until she was admitted for study. There was no recent history of jaundice or of pruritus.

Examination.—*Routine physical examination* was essentially negative except for a marked scoliosis of her spine.

Dr A M Sharpe reported as follows on the *gastro intestinal x ray findings*. Fluoroscopically the heart and lungs appeared normal. Abdominal control exposure. There is a marked spinal curvature which consists of a right sciatic scoliosis, a right convex dorsolumbar scoliosis and a cervico-axial compensatory upper thoracic curvature. The esophagus and swallowing function were normal. Duodenal cap was relatively large but filled completely and emptied readily and was not tender to pressure. With the patient prone there was a rounded pressure defect on the inferior surface of the duodenal cap. The duodenal loop and upper jejunal coils appeared normal. The stomach was empty at the six hour period. The head of the meal was approaching the cecum. In twenty four hours the meal was distributed throughout the large bowel. Results from the barium enema are negative. The Graham Cole test sixteen hours after oral administration of dye failed to show any evidence of a gallbladder shadow. Inference: Nonfunctioning gallbladder of any background. Most of these cases are associated with stones. However patient's clinical history and the presence of a small extrinsic pressure defect on duodenal cap aroused the suspicion of early malignancy of the pancreas or common duct.

Examination at this time revealed a mild icterus and a palpable mass in the region of the gallbladder. The van den Bergh test was immediate direct icterus index 30 units and quantitative serum bilirubin 14 mg per 100 cc. of serum. Blood count: hemoglobin 83 per cent, red blood cells 4,540,000, white blood cells 5,400, neutrophils, 73 per cent, lymphocytes, 23 per cent, monocytes per cent, eosinophils 1 per cent, basophils 1 per cent.

In spite of the rather clear-cut picture of malignancy of the pancreas it was thought advisable to re-evaluate the patient in two weeks time. Our decision may have been influenced by a laparotomy performed on a patient with catarrhal jaundice shortly before this time. In the meantime, the patient was prepared for surgery by high protein and high carbohydrate diet, bile salts and vitamin K.

The patient was re-admitted on November 1943. Her icterus index had risen to 100 + quantitative bilirubin was 5 mg per 100 cc. and cholesterol 1.8 mg. Her prothrombin was normal.

Operation (Figs 487-488).—On November 9 1943 under continuous spinal anesthesia a laparotomy was done through a right rectus incision. A greatly distended gallbladder and common duct were exposed. A mass which appeared movable was felt in the head of the pancreas. The distended gallbladder interfered with exposure therefore it was drained of normal colored bile. A radical resection in one stage was decided upon. The stomach was divided proximal to the pylorus and closed. The duodenum was freed and divided 5 cm. distal to the lesion. The common duct was isolated ligated and divided. The closure was reinforced by interrupted sutures of silk. The body of the pancreas

was then bisected 3 cm from the lesion. Two distended ducts were separately ligated and the pancreas turned in with silk. The head of the pancreas was markedly adherent to the portal vein and it had to be freed from it by sharp dissection. The jejunum could not be brought in contact with the gallbladder without tension probably because of the marked scoliosis but as the distal end of the duodenum was readily available I made an anastomosis between the gallbladder and duodenum. Silk was used for the serosal layer and catgut for the mucosal in all the anastomoses. Following this a routine retrocolic posterior gastrojejunostomy was done. Two cigarette drains were placed next to the bisected pancreas and brought out through a stab wound. The peritoneum was closed with catgut the anterior rectus

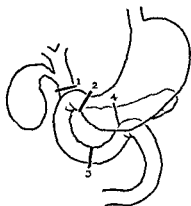


Fig 487

Fig 487—Schematic drawing showing points of division (1 2 3 4) as described in the operative note

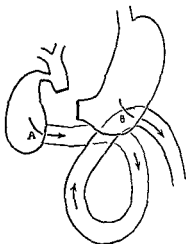


Fig 488

Fig 488—Schematic representation following anastomosis. Pancreas and transverse colon are not shown for the sake of clarity

sheath with catgut and tension sutures of wire and the skin with wire. The patient received 500 cc of blood and 800 cc of normal saline on the table.

Pathologic Report—The pancreas is situated in the duodenum with atypical glandular structure showing marked dysplasia and mitotic figures. The infiltrative tendency extends all the way to the edge of the tissue which seems to show that the tumor has not been completely removed. The parenchyma of the pancreas is largely replaced by fibrous tissue although the islets of Langerhans are all preserved. Diagnosis: adenocarcinoma of pancreas.

Postoperative Course—The postoperative course is extremely smooth. Within sixteen suction was maintained for three days and parietal fluid gained for a week. Starting on the third postoperative day and lasting until the twelfth postoperative day there was profuse drainage from the stab wound of which

was assumed to be pancreatic juice. No bile was ever noted in this drainage. Ten days after operation the van den Bergh (quantitative) had fallen to 7.5 mg per 100 cc and twenty three days postoperative to 19 mg per 100 cc with an icterus index of 30 units. The patient was discharged from the hospital on her twenty third postoperative day.

Following her discharge from the hospital the patient's course has on the whole been entirely satisfactory. She has gained strength and now follows her usual activities. There has been a minimal gain in weight. In spite of the absence of external secretion of the pancreas she had no untoward symptoms until



Fig. 489.—X ray film showing functioning gastro enterostomy proximal loop air outlining gallbladder and biliary radicles.

March, 1944 when she noted a heavy yellow-orange colored discharge with very bowel movement which at times caused incontinence. In April she started taking Panteric tablets (Parke Davis) 5 grains three times a day and the discharge promptly ceased. Since then she has continued taking these with no further trouble.

Check-up Study.—A check up gastro-intestinal x ray study was made on June 8, 1944 (Fig 489). The pyloric end of the stomach, duodenal cap and a portion of the superior duodenal loop are missing. There is a well functioning gastro-enterostomy stoma which appears to be the only exit for the opaque meal from the stomach to the small bowel. Ninety five per cent of the meal takes the

effluent small bowel loop pathway approximately 5 per cent seeps to the back through the afferent loop into the gallbladder. The stomach was empty at the end of the five hour period. There are no intrinsic organic lesions within the stomach or small bowel coils or evidences of pressure defects from extrinsic glandular neoplasms.

On July 6, 1944 the van den Bergh test was negative and the icterus index was 3 units. The blood count showed 78 per cent hemoglobin, 4,140,000 red blood cells and 4400 white blood cells with 67 per cent neutrophils, 32 per cent lymphocytes and 1 per cent eosinophils.

COMMENT

A successful radical pancreatoduodenal resection has been reported. Although it is the consensus that the biliary tract is preferably ana-

TABLE 1—LABORATORY AIDS IN THE DIFFERENTIAL DIAGNOSIS OF SURGICAL AND NONSURGICAL HEPATOCELLULAR JAUNDICE

	Surgical		Non-surgical
	Benign	Malignant	Hepatocellular or Catarrhal
Van den Bergh test	Biliphase	Direct	Biliphase
Icterus index	20 to 60	100	10 to 100+
Urobilinogen in urine	Usually present	Usually absent	Excessive amount
Calciotesterase	Excretion usually less than 3 gm.	Excretion usually less than 3 gm.	Excretion of more than 3 gm.
Duodenal drainage	Cholesterol crystals and calcium bilirubinate	Whole blood	Mucus and pus
Blood cholesterol	180 mg per cent or more	180 mg or more per 100 cc	Less than 180 mg per 100 cc
Prothrombin (Olin)	Response to vitamin K	Response to vitamin K	Decreased response to vitamin K
X-ray (Trotter method)	Outline of extrahepatic biliary tree	Outline of extrahepatic biliary tree	Non-visualization of extrahepatic biliary tree
Crohn's intestinal series		Irradiation of the small intestine and duodenum	
Hematology (Waugh)	Leukocytosis with lymphocytosis	Leukocytosis with lymphopenia	Neutropenia and moderate lymphocytosis
Cephalic cholecystoculaculation test (Nadler and Butler)	Negative or faintly positive	Negative or faintly positive	Strongly positive

removed to the jejunum such an anastomosis was impossible in this case. The blind end of the duodenum was therefore utilized with a highly satisfactory result. This emphasizes the fact that one should never become a slave to established custom. As long as physiologic function is restored the less important steps in technic can be individualized.

TABLE 2—HISTORY, SYMPTOMS AND PHYSICAL SIGNS IN THE DIFFERENTIAL DIAGNOSIS OF SURGICAL AND NONSURGICAL HEPATOCELLULAR JAUNDICE

	Surgical (60-65 Per Cent)		Nonsurgical (35-40 Per Cent)
	Benign	Malignant	Hepatocellular or Catarrhal
Percentage	35 per cent	30 per cent	35 per cent
Age	4th decade	5th decade	Any age
Sex	Even distribution	Male predominate	Even distribution
History	Pain—typical colic Require morphine	Discomfort noncolic No morphine	No pain No morphine
Past medical history	Suggestive of gall bladder disease	Negative	Negative
Duration of symptoms	3 years	Less than a year	Short
Marked pruritus	Few	Common	Not marked
Sepsis (chills and fever)	Common	Rare	Rare
Weight loss	Uncommon	Usual	Not marked
General appearance	Not critically ill	Critically ill	Apathetic
Jaundice	Not as intense yellow	Greenish yellow	Reddish yellow
Physical examination	Tenderness right upper quadrant	Mass (distended gallbladder)	Enlarged liver
Alcoholic stools	Complete rare	Common	Complete rare

Permanent cure of carcinoma of the head of the pancreas will follow the successful resections only rarely. The anatomic position of the pancreas adjacent to vital structures (portal vein) which cannot be sacrificed prevents one from doing a wide resection of the growth. However, life expectancy can be increased as in this case in spite of the fact that the pathologist found the tumor at the very edge of the resected tissue.

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THE PHARMACOLOGICAL BASIS FOR PREOPERATIVE MEDICATION

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ANESTHESIA can be made more satisfactory by the administration of certain drugs in the preoperative period. It is likewise true that the casual or uninformed supervision of such medication may obstruct rather than aid in the production of the desired results. It is proposed therefore to consider the pharmacological and clinical action of the drugs commonly used prior to surgery and to outline the basic principles upon which their most efficient use depends. The discussion will be limited to three topics: choice of drug, time and route of administration and dosage.

I. CHOICE OF DRUG

Preoperative medication is intended to accomplish a variety of purposes. Before a particular drug can be intelligently selected these purposes must be defined. They include sedation, protection against the toxicity of local anesthetic agents, paralysis of certain parasympathetic nerve pathways and maintenance of circulation during spinal anesthesia.

1. Sedation.—The individual facing surgery is apprehensive and anxious regardless of his mental make up and sedatives are indicated for the relief of this perfectly normal nervous tension. In addition to the psychic benefit derived, however, the production of mental calm is also accompanied by a reduction in the reactivity and irritability of all body tissues. Oxygen consumption is decreased, muscular and nervous system irritability is diminished and as a consequence of this slowing up of general metabolism less anesthetic agent is required.¹ A successfully gauged dose of opiate or barbiturate results in a smoother and more rapid induction of general anesthesia and a more even maintenance. Control of the depth of anesthesia is easier and the actual amount of supplemental agent required is reduced.

The drugs most frequently employed to meet these requirements are the opiates and various derivatives of barbituric acid. The characteristics of each group will be briefly presented.

OPIATES.—*Morphine* is the sheet anchor for preoperative sedation and is the standard to which the other members of the group such

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as dilaudid pantopon and codeine must be compared. It is a veritable pharmacologic storehouse with a variety of actions on the central nervous system and on smooth muscle throughout the body. Since the drug is employed so frequently in surgery it will be instructive to list the most important effects of morphine and to suggest the probable physiological basis for such findings.

<i>Subject and Objective Findings</i>	<i>Explained entirely or partially by</i>
1 Relief of anxiety, sleepiness, occasional euphoria Relief of pain	1 Depression of cerebral centers.
2 Decreased respiratory rate and minute volume	2 Thalamic depression altered mental outlook
3 Hunger, contractile rumbling in abdomen	3 Depression of medullary respiratory center
4 Occasional nausea or vomiting more likely if the patient is ambulatory or during change in position	4 Contraction second part of duodenum increased tone small bowel
5 Constipation	5 Alteration in vestibular function stimulation of vomiting center in medulla alteration in gastrointestinal function
Vertigo particularly when position changed	6 Secondary decrease in tone of small bowel decreased appreciation of defecation reflex
8 Itching in bluish area	7 Decreased cerebral blood flow from pooling of blood in dependent, dilated peripheral vessels
9 Increased difficulty of breathing in asthmatics	8 Cutaneous vasodilatation in this area
10 Increase in the pain of biliary and ureteral colic	9 Bronchiolar constriction drying of secretions in bronchi
	10 Contraction of smooth muscle of these organs

The *central nervous system actions* of morphine items 1 and 2 in the above column are the ones sought most often and are familiar to all. Certain factors governing the degree of depression are less well known, however. This depressant action of morphine can be antagonized and counteracted by excitement, fear or pain. It is a relative matter, therefore, and will vary according to the patient's preoperative status. The effect of this upon dosage is considered below.

The *gastrointestinal effects* are extremely important. Administration of morphine to normal subjects produces nausea and vomiting in a large percentage.³ As long as these individuals remain flat in bed they are reasonably comfortable, but upon arising nausea with or without retching often occurs. The same situation exists in patients receiving morphine, but for several reasons the incidence is much lower. In the first place the patient is rarely ambulatory. In the second place sufficient time does not elapse between injection and the surgical procedure to properly evaluate the response. Nausea and vomiting are relatively delayed manifestations and may not occur for

two to three hours or more. Careful questioning of patients as they arrive in the operating room however will reveal a definite number who are experiencing such disturbances. Not infrequently this is brought out during transfer from the litter or as the patient is turned preparatory to administering spinal anesthesia. The postural factor is obvious.

A final point should be made. Morphine can and often does cause nausea and vomiting in the postoperative period. Too often is this regarded as part of the immediate surgical convalescence. The prn or every fourth hour order for morphine is a pernicious habit and withdrawal of the drug is frequently followed by prompt cessation of gastrointestinal difficulties. Dilaudid and pantopon are believed by some individuals to produce less gastrointestinal symptoms and for this reason are chosen when a patient gives a history of such distress following morphine. The actual advantages of these substances over morphine are often more apparent than real and little experimental evidence exists on which such claims may be based. There is no doubt however that codeine is accompanied by less nausea and vomiting and it is unfortunate that this valuable member of the group is not used more often.

The *smooth muscle stimulant actions* of morphine manifest by bronchiolar constriction and spasm of bile ducts and ureters are obvious disadvantages and may serve as contraindications for the drug under certain circumstances. These actions are decreased to some extent by the concomitant administration of atropine or scopolamine.

The *vascular action* of morphine is less well understood but certain clinical impressions should be mentioned. The use of the drug may be followed by a decrease in arterial blood pressure occasionally of alarming proportions. It is wise therefore to check the preoperative blood pressure of patients before and after the administration of the drug and to seriously consider postponing surgery in those patients in whom a definite drop in pressure is noted. They do not stand surgery well. Whether this response is attributable to peripheral vasodilatation, depression of the medullary vasomotor center or merely represents an individual idiosyncrasy is not known. It is more commonly seen in older individuals.

BARBITURATES—Because of the wide variety of actions which follow use of the opiates many anesthetists and surgeons prefer barbituric acid derivatives. As a group these substances differ from the opiates in that they produce only depression of the central nervous system. They do not possess the smooth muscle stimulant properties of the morphine series.

Some 1500 derivatives of barbituric acid have been synthesized and the selection of one barbiturate over another is often difficult. The choice depends upon how soon one wishes the drug to be effective after administration and how long one wishes the action to per-

of this data one of the members of this group is usually administered before injection of local anesthetic agents

3 *Paralysis of Certain Parasympathetic Nerve Pathways*—(a) *Secretions*—General anesthesia is often accompanied by an outpouring of secretions from the salivary glands and the mucosa of the respiratory tract. The belladonna drugs atropine and scopolamine (hyoscine) minimize these secretions by blocking the parasympathetic nerves to the secreting glands. This action is particularly important where unskilled anesthetists are at work. Outpouring of mucus particularly during ether anesthesia is more likely to occur during the slow uneven induction common to the inexperienced. This mucus may produce laryngospasm from direct irritation of the vocal cords. It may be swallowed and carry ether into the stomach and it is common knowledge that the patient who is wet during the maintenance of inhalation anesthesia has a more stormy postoperative course with increased nausea and vomiting and a greater likelihood of pulmonary complications.

(b) *Reflexes*—Reflex slowing or complete arrest of the heart may occur during manipulations which stimulate the cardiac vagus.⁵ This may occur during intrathoracic surgery when structures at the hilus of the lung are disturbed or may follow procedures in the neck in which case a hypersensitive carotid sinus mechanism may be stimulated. The belladonna group can prevent this reaction by blocking the vagal fibers to the heart. Fairly large doses (0.8 mg [1/8 grain]) are required.

During intravenous anesthesia with the barbiturates a reflex spasm of the vocal cords is reported.⁶ Experimental evidence suggests that this can be prevented or even treated with large doses of *atropine*. The pharmacologic basis for such a result is not clear. It cannot be due to a block of the motor nerves to the larynx as has been suggested because atropine does not affect the transmission of impulses over the superior or inferior laryngeal nerve. Whatever the ultimate site of action the drug should be given preoperatively until further analysis of the action is available. It is also true that clinical experience in the treatment of severe laryngospasm with intravenously administered atropine is less satisfactory than that obtained with the relatively huge doses given to animals. If one is tempted to employ large doses intravenously in man it should be remembered that large doses of this drug may be followed by a sharp rise in heart rate secondary to vagal inhibition. This tachycardia may constitute a grave strain on a weakened myocardium and may precipitate cardiac failure.

Comparison of Effects of Scopolamine and Atropine—In considering which member of the belladonna series to employ preoperatively the following comparison of scopolamine and atropine may be helpful.

1 Scopolamine produces a greater subjective sensation of dryness in the mouth.

2 Both drugs tend to counteract the respiratory depression of morphine but scopolamine is more potent in this regard?

3 Scopolamine contributes in its own right to the lessening of anxiety. This is characterized by a "don't give a darn" attitude. It is definitely amnesic.

4 Scopolamine is more likely than atropine to produce excitement. This reaction occurs more frequently in the extremes of the age groups—i.e. in the very young and the very old. Atropine is preferable here.

5 A scarlatiniform rash with circumoral pallor may follow both drugs particularly in children.

6 A rise in temperature of several degrees may be noted and more often in infants under one year of age. This is probably due to decreased heat elimination since the sweat glands are blocked and heat retention occurs. Increased heat production from direct central stimulation may also be a factor.

4 Maintenance of Circulation during Spinal Anesthesia—A pressor drug is almost invariably administered before spinal anesthesia in an effort to prevent the fall in blood pressure which may follow this procedure. Ephedrine, epinephrine, pateridine, methedrine and norepinephrin have all been advocated and it is difficult to decide which substance is most efficient. The experimental evidence at hand is not convincing and many of the statements in the clinical literature are based on uncontrolled observations. One's own familiarity with a particular drug is as good a guide as any at the present time. The combination of ephedrine and pitressin has also been used. The latter drug exerts its pressor action by direct stimulation of arterial and capillary smooth muscle. Unfortunately, however, the drug may be depressant to the myocardium perhaps as the result of coronary artery constriction. The addition of ephedrine is alleged to counteract this coronary spasm but the two drugs are probably contraindicated in the presence of coronary artery disease.

A number of individuals have expressed the opinion that pressor drugs should not be given to hypertensive patients receiving spinal anesthesia. Their fear is that a sharp rise in blood pressure will occur and be followed by myocardial or cerebral catastrophes. This is not in keeping with the facts. The dose of pressor drug usually administered prior to spinal anesthesia may cause no rise in arterial pressure or may produce at the most an elevation of 20 to 30 mm. of mercury. This rise is far less than these patients experience while straining at stool, lifting heavy objects and the like. If such a variation can be tolerated under those conditions, no harm should result from a modest rise caused by drugs. Furthermore, these individuals with hypertension must not be permitted to suffer depression of blood pressure during anesthesia and are therefore the very patients to whom sympathomimetic amines should be given.

The intelligent use of these drugs depends on a knowledge of the physiological alterations responsible for the drop in blood pressure following spinal anesthesia. The major changes caused by subarachnoid anesthesia are as follows. There is paralysis of vasoconstrictor sympathetic fibers to arterioles with a decreased peripheral resistance. These fibers arise from the spinal cord in the thoracolumbar area so that the higher the anesthesia the more paths are blocked. Smith and his co-workers⁸ have questioned the importance of constrictor impulses in the maintenance of arteriolar tone but it is difficult to avoid the conclusion that such impulses do play a part.

Spinal anesthesia also affects the venous side of the circulation in a number of ways. Paralysis of skeletal muscle decreases the muscle pump action and reduces venous return to the right side of the heart. Varying degrees of intercostal muscle paralysis likewise decrease the inspiratory thoracic pump action which brings blood into the great veins. In addition there may be actual dilatation of veins with pooling of blood in these vessels. All of these factors decrease venous return; venous pressure falls and cardiac output is reduced. This has been measured directly.⁸

Finally, the inefficient respiratory mechanism secondary to intercostal muscle block produces anoxia with subsequent damage to cellular function throughout the body.⁹ As the result of oxygen deprivation and diminished minute volume blood flow, nervous mechanisms which might compensate for some of the alterations in function are weakened and less effective. A vicious cycle is set up which must be broken.

The prophylactic use of pressor drugs is indicated because of certain pharmacologic characteristics of these substances. The assumption is often made that their value depends only upon the production of peripheral arteriolar constriction. This to be sure affords effective chemical substitution for central vasomotor tone but it is not the whole story. These drugs are also powerful stimulants of heart muscle and tend to increase cardiac output.¹⁰ They stimulate cells in the central nervous system. And, although less susceptible to experimental proof, there is evidence to indicate that some of these substances increase venous tone and tend to prevent venous stasis. It can be seen that this combination of effects is just what is needed to prevent a decrease in blood pressure after spinal anesthesia or to treat such hypotens on once it has developed.

II TIME AND ROUTE OF ADMINISTRATION

Four different groups of drugs have been discussed so far: opiates, barbiturates, belladonna derivatives and pressor drugs. Each serves a definite purpose in the preoperative program and to fulfill this function properly the time relationships of each must be learned. There is an optimum time for each group to be administered and since this factor

varies with the route of administration both problems will be considered together

The opiates are usually given subcutaneously although in recent years the intravenous route has been used increasingly. If these drugs are to precede a general anesthetic it is desirable that their maximal respiratory depression be reached before the major anesthetic agent is started. Failure to observe this precaution may result in an additive effect the depressant action of the anesthetic being combined with that of the opiate. This can be particularly unpleasant when the general anesthetic is markedly depressant to breathing i.e. pentothal and cyclopropane. In such instances one is combining two substances both of which decrease the activity of the medullary respiratory center.

Respiratory depression is undesirable in its own right yet where it exists during the attempted induction of an inhalation anesthetic it can be doubly annoying. Such a depressed patient will not breathe deeply enough to move the anesthetic agent into his alveoli and blood stream. Anesthesia will be slow and irregular in onset.

To prevent this the opiates are best administered subcutaneously one and one half hours prior to the expected induction time.¹¹ By then maximal respiration depression will have been reached or passed.

If one is faced with emergency surgery the opiates can be given by vein. Maximal respiratory depression comes on rapidly (within three to five minutes) and begins to wear off within fifteen to twenty minutes. It is surprising how well intravenous morphine is tolerated by reasonably fit patients. Little disturbance in blood pressure or minute volume of respiration is noted in the average case.⁸ As Beecher has strikingly illustrated the intravenous route guarantees absorption.¹² He found that shocked patients did not absorb morphine after subcutaneous or intramuscular administration because of decreased peripheral circulation. Second injections were made when no action was apparent after the first dose. When the shock was treated and blood pressure rose morphine was then absorbed and signs of overdosage occurred.

Opiates are also used prior to regional anesthesia. The hazards of respiratory depression are less in such cases. The ideal result is to obtain maximal sedation at the time the operative procedure is to be undertaken. This means the hypodermic should be given one hour preoperatively.

Barbiturates are usually given by mouth. To provide a more restful sleep before surgery these drugs are given at bedtime. They may then be repeated one and one half hours before operation. Respiratory depression is less than with the opiates.

The belladonna derivatives exert action rapidly and over a relatively brief period of time. Ideally therefore to insure a maximal drying effect they should be given fifteen to twenty minutes prior to general anesthesia. This is rarely done however in actual practice.

and the drugs are combined with the opiate and given much too soon. The combination of a barbiturate and atropine or scopolamine is effective for the former is given orally and the latter can be withheld until the patient is called to the clinic.

Both atropine and scopolamine may be administered intravenously when an exceptionally rapid effect is desired.

Pressor drugs are best injected intramuscularly thirty minutes before spinal anesthesia is scheduled. Many clinics do not use this technic preferring to have such an injection made at the time the lumbar puncture is being performed. A satisfactory compromise is to inject the selected drug at both times insuring adequate time for circulatory support. Often when administration is delayed until the spinal anesthetic is given there is insufficient time allowed for the drug to exert its action.

III DOSAGE

1 *Sedatives*—The dose of a sedative will vary according to the patient's age, mental make up and physical condition. It is unfortunate that a standard dose is so frequently chosen in surgical practice and applied at will to the young, the old, the fat and the lean. There can be no satisfactory use of depressants unless they be shaped to fit the individual.

The basic principle involved in grading dosage is the general irritability or reactivity of body tissues as a whole. This can be summarized in the term *metabolism*. The higher the metabolism, the greater the dose of narcotic required to produce comparable degrees of depression. Our concern must therefore be with these factors which influence metabolic rate.

There is a definite relationship between age and metabolism. Figure 490 (after Guedel) illustrates the metabolic activity at various ages.

Certain conclusions can be drawn from this as to the effect of age on dosage schedules. First, young infants and older people require the least amount of depressants. Second, at puberty metabolism is highest and sedation is more difficult to obtain. This graph may be set at a higher level, i.e. the metabolic activity may be increased by several factors. These include pain, fear, fever and variations in an individual's endocrine status.

The antagonism of pain and narcosis has been known for centuries, flagellation being one of the therapeutic approaches to overdose of depressants. The recent work of Wolff, Hardy and Goodell¹³ has placed this on a firm scientific basis. They measured the ability of morphine to raise the pain threshold. If pain was present before the opiate was administered, this threshold-raising action was found to be reduced or abolished altogether. In an attempt to analyze the reasons behind such an observation, these investigators thought of adrenalin. The idea was this: pain leads to increased activity of the sympathetic nervous system and an increased secretion of adrenalin.

Did this latter substance have any effect on the action of morphine?

Interestingly enough the subcutaneous injection of adrenalin two hours before the administration of morphine reduced in some instances and completely abolished in others the ability of opiates to raise the pain threshold. And it was not only pain relief which was antagonized but also the psychic and respiratory effects of the opiates.

Clinical implications of these experiments are obvious. If a patient is in severe pain he may resist large doses of an opiate without showing respiratory depression. If this pain be suddenly relieved respiratory depression then may be pronounced. Such is the case when one is treating the pain of biliary or ureteral stone relief from which may be suddenly obtained with passage of the calculus.



Fig. 490—Metabolic activity at various ages

The emotional make up of an individual also gives a clue as to whether dosage must be altered. The alert active patient will require more sedation than a phlegmatic apathetic person. This is directly related to the endocrine status. It is common knowledge that a patient with hyperthyroidism is resistant to narcosis whereas small doses of a depressant drug may produce profound effect in one whose thyroid is underfunctioning. Finally, toxemia and fever elevate metabolic activity. It is usually stated that a one degree (F) rise in body temperature is accompanied by an increase of 7 per cent in the metabolic rate.

These general principles are reviewed as one sizes up each patient and gauges the amount of preoperative sedation required.

The final dose selected will vary with the type of anesthesia planned. Patients facing local or spinal anesthesia can safely be given larger

doses for no further depressant drug is to be used. If general anesthesia has been selected the particular agent chosen should be considered. Cyclopropane and pentothal are powerful respiratory depressants and a smaller dose of preoperative opiate is indicated than with ether which tends to stimulate medullary function reflexly.¹⁴ Nitrous oxide and ethylene are weak anesthetics and if adequate narcosis is to be achieved without anoxia larger doses of the preoperative sedative must be given.

2 Belladonna Group—Several peculiarities of dosage should be mentioned for these drugs. The Negro requires more than the white individual. Children are not as susceptible to atropine as is frequently believed. Almost any child over the age of two can tolerate 0.4 mg ($\frac{1}{150}$ grain) administered subcutaneously. Whatever susceptibility there is is more evident in infants under one year of age. The average adult is best given 0.6 mg ($\frac{1}{100}$ grain). Waters¹¹ feels that a ratio of 2:1 is most satisfactory for the combination of morphine and atropine or scopolamine. Thus an individual receiving 10 mg of morphine would be given 0.4 mg of the belladonna drug chosen.

3 Pressor Drugs—The dose of these substances for use intramuscularly prior to spinal anesthesia varies according to personal feelings. A satisfactory range for the groups of drugs listed would be as follows:

(a) Ephedrine sulfate	50 mg
(b) Paredrine hydrobromide	10-20 mg
(c) Neosynephrin hydrochloride	1-5 mg
(d) Methedrine hydrochloride	20 mg

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From Walter Reed General Hospital, Washington, D C

PENICILLIN IN THE TREATMENT OF SURGICAL INFECTIONS OF THE CENTRAL NERVOUS SYSTEM

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THE treatment of surgical infections of the central nervous system was tremendously improved with the advent of the sulfonamides. The use of penicillin in these cases has now added another powerful agent for the further control of the high mortality associated with cerebral abscess. The method of administration of the drug in such infections however varies in significant detail from its use in infections elsewhere in the body.

It has been shown by Rammelkamp and Keefer¹ (in the treatment of meningitis) that penicillin passes through the choroid plexus into the cerebrospinal fluid only in minute traces and certainly not in any therapeutic amounts. Pilcher has shown experimentally in dogs that penicillin given intravenously is ineffective in the treatment of staphylococcal and pneumococcal meningitis whereas a marked beneficial effect is apparent when the drug is administered intrathecally. In the treatment of brain abscess produced by staphylococcus he has been unable to demonstrate any beneficial effect of penicillin given intravenously or intrathecally with the possible exception of some diminution in the likelihood of developing an associated meningitis.

The twelve cases of infections of the central nervous system presented in this paper confirm these experimental studies and present other features of interest and importance in the use of this valuable therapeutic agent. The group of cases to be discussed consists of six cases of brain abscess, four of epidural abscess and two of traumatic meningitis. They are classified and summarized in the table. The treatment of each group has been presented in manner and one case from each group is noted in detail.

BRAIN ABSCESS

The six brain abscesses outlined in the table. Cases I and II are secondary to sinusitis. Cases III

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SUMMARY OF THE TWELVE CASES PRESENTED

Case	Description of Lesion	Bacteriology	Sulfathiazole Therapy	Description of Treatment	Outcome
BRAIN ABSCESS					
I	Primary. Secondary to the probably by direct extension on the right of the frontal bone abscess epidural, subdural and left frontotemporal lobe	Staph aureus from the pus of skull An aerobic beta hemolytic streptococcus from brain abscess.	5 days of sulfadiazine (blood level 9.47) before starting penicillin	Penicillin Intramuscularly beginning 240,000 U daily Total 15,730,500 U Local instillation into brain abscess plus 50,000 to 75,000 U per injection Surgery Sequestrectomy left frontal bone and drainage of subdural and epidural abscesses, 16th day Multiple aspirations of brain abscess 5th to 102nd days. Final resolution of brain abscess 107th day	Complete recovery 120th day. Frontal bone cranioplasty and returned to duty
II	Proximal sinusitis. Secondary to this subdural abscess and questionable meningitis (sterile spinal fluid with 200 WBC). Two months later large left frontal lobe abscess.	Spinal fluid no growth Subdural hemolytic Staph aureus from brain abscess. Bacterial streptococcus in cerebrospinal fluid. Staph aureus	Sulfadiazine administered along with penicillin (Blood level 10.4) Resulted along with penicillin 60th day (14 days)	Penicillin Intramuscularly starting with 120,000 U daily Total 13,860,000 U Local (1) Into brain abscess 30,000 U (2) Into subdural abscess 30,000 U tapped cerebrospinal fluid (3) Intrathecal 110,000 U (4) Sterile (1) Multiple drainage of subdural abscesses (2) Multiple drainage of brain abscesses	An acute cerebritis with suppuration was controlled. Patient was ambulatory for 1 month but with residual cerebral neurological deficit. Then on week after cessation of parenteral penicillin abscess ruptured into ventricle. Patient remained on penicillin and drainage (additional to sterile drainage)

SUMMARY OF THE TWELVE CASES PRESENTED—Continued

Case	Description of Lesion	Bacteriology	Saliva Therapy	Description of Treatment	Outcome
EPIDURAL ABSCESS					
VII	Postoperative epidural abscess complicating lumbar cord following laminectomy for ruptured intervertebral disk	Beta hemolytic streptococcus sensitive to 0.0025 U penicillin	No prophylactic or few oral doses before institution of penicillin therapy	Penicillin Intramuscularly beginning 90,000 U daily Total 660,000 U Local instillations first 6 days Wound opened 2 cm and soft rubber catheter inserted	Subsidence of fever by crisis in 48 hours. Wound healed about 20th day leaving 1 near 1 inch scar. Radical decompression observed. Returned to duty.
VIII	Large hematogenous epidural abscess of dorsal cord (T5 to T11) with intracranial extension	Hemolytic Staphylococcus aureus, coagulase positive sensitive to 4 U penicillin	None	Penicillin Intramuscularly beginning 240,000 U daily Total 650,000 U Local instillations for 13 days Postoperative Surgery D compressive laminectomy at site and successful closure of wound on 29th day	Ambulatory 12 days after secondary closure. Returned to duty 165th day.
IX	Postoperative epidural abscess complicating lumbar cord following laminectomy for ruptured intervertebral disk. Numbness of leg 60 days	Hemolytic Staphylococcus aureus, coagulase positive, sensitive to 0.008 U penicillin	1 month oral sulfadiazine before institution	Penicillin Intramuscularly beginning 240,000 U daily Total 4,775,000 U Local penicillin pack only to postoperative Surgery Squeezed out myelogram 4th day Laminectomy 13th day	Complete healing in 41 days. Returned to duty 126th day.

I	Top right, leomyitis of fifth lumbar vertebra with epidural abscess 50 days old	Staphylococcus aureus	Sulfamizone given at 2 weeks with penicillin therapy	Penicillin Intramuscular 30,000 U daily Total 150,000 U No explanation of wound	Meningitis cleared at this point intrathecal (but not intramuscular) sulfadiazine dosage was stopped. Meningitis recurred to be again cured by 10 July intrathecal injections
VI	Meningitis following basilar skull fracture compound fracture of right femur	Intravenous type IV	Adequate intravenous and oral dosage (blood levels averaging 3.4 to 8.3 mg) for 10 days	Penicillin Intramuscular beginning 210,000 U daily Total 10,050,000 U Intrathecal instillation intrathecal and intracisterna 5/16 5/27/11 resumed 6/5 6/11/11 Total local dose 16,450,000 U	Meningitis cleared 5/27/11 At this point intrathecal (but not intramuscular) sulfadiazine dosage was stopped. Meningitis recurred to be again cured by 10 July intrathecal injections
VII	Meningitis following basilar skull fracture compound fracture of right frontal sinus	Coagulation positive Staphylococcus aureus	Sulfamizone average 5 gm daily 6/24 7/18/13 except 10 days penicillin 6/28 7/7/14	Penicillin Intrathecal 5000 to 17,500 U daily 6/28 7/7/13 Intravenously 7,500 U 7/5/11 and 6,000 U 7/7/13 Total 112,500 U	After 4 days sulfonamide therapy spinal fluid culture still positive and patient still comatose. After 3 days intrathecal penicillin spinal fluid sterilized. At end of 10 days intrathecal and intraventricular clinical cure of meningitis

Refers to the day of penicillin

† While on sulfa drug patient reinfected himself and returned to hospital with meningitis. He is again improving nicely on intrathecal penicillin alone.

from pulmonary suppuration a condition heretofore generally recognized as invariably fatal. The second of these is the one fatality in this series. The remaining cases V and VI represent abscesses following surgical procedure and may be considered similar in nature to abscesses resulting from penetrating wounds of the brain.

The initial development of a brain abscess is associated with a surrounding zone of *cerebritis* similar to the zone of cellulitis surrounding an early furuncle or carbuncle. Indeed in metastatic brain abscesses this early inflammatory reaction is probably widespread and intense even before much central liquefaction and pus formation occurs. It is this marked edema within the closed intracranial space together with the absorption of bacterial toxins that has heretofore defied all combinations of chemotherapy and surgery.

It is in the control of such *cerebritis* that penicillin appears particularly valuable as may be inferred by a consideration of Case III where a diffuse infection became localized and thus was made amenable to surgery. It is to be emphasized that once formed an abscess is no longer benefited by parenteral therapy and surgical drainage is imperative. Even here penicillin plays a protective role in preventing the spread of infection during surgical procedures such as aspiration and open drainage. This is well illustrated by the low morbidity in all the abscesses in this group once the surgical stage was achieved.

Once the abscess is formed as above stated parenteral penicillin no longer is of benefit. Thus the bio assay (Rammelkamp and Keefer³) of the pus from the abscess cavity made while the patient in Case I was receiving 120 000 units daily revealed no detectable penicillin. Clinically too during this time the patient ran a low fever and made no progress. Parenteral therapy was then discontinued and injections directly into the abscess cavity were started. When 15 000 to 70 000 units were injected the infecting organism (an anaerobic streptococcus) persisted in heavy growth. However when this was increased to 50 000 to 75 000 units the cavity was sterilized. Later when the thick walled cavity was resected surgically both the contents and the pyogenic membrane were sterile and the patient made an uneventful recovery. In short adequate parenteral penicillin is indicated during the early *cerebritis* stage of brain abscess when the blood stream will carry it to the infiltrating bacteria. Likewise it is indicated as a prophylaxis against dissemination of infection at the time of any surgical procedure in an infected field. Once an encapsulated abscess has formed parenteral penicillin no longer has any effect but local injections when possible may sterilize the abscess.

A word should be said in regard to Case IV in which occurred the only death in this series. This is a classic example of fatal secondary brain abscess in an already debilitated sufferer from chronic empyema. Up to his sudden exitus on the third day of penicillin therapy he seemed to be making slight improvement although he re-

the white blood cell count was 1 800 (polymorphonuclears 8 per cent) and the urine was clear. Blood chemistry including blood protein was normal. The sputum was not foul and cultures showed an alpha Streptococcus salivarius and an alpha Streptococcus mitis. The blood and spinal fluid cultures never became positive.

Beginning on October 11 the patient received daily penicillin doses of 360 000 to 480 000 units given by constant intravenous drip and later by the intramuscular route. The final total dosage after fifty three days treatment, was 14 435 000 units (See Fig 491).

Within twenty two hours there was dramatic improvement which continued until October 24 when pains developed of an expanding abscess in the left scapular region. A large abscess in this lobe was drained; the culture showed a non hemolytic streptococcus susceptible to 0.001 units of penicillin. Following the craniotomy the patient received five injections of penicillin each 8000 to 10 000 units directly into the abscess. From this time recovery was uneventful. The craniotomy wound healing on November 21. The patient was last seen May 1944 at which time his only complaints were some dizziness and vertigo on standing and upon first arising in the morning. He returned to full duty.

EPIDURAL ABSCESS

Such abscesses are of two types. The first is an *acute infection of the epidural space* occurring as the result of a septicemia or of postoperative sepsis in closed wounds. When this condition develops about the spinal cord it represents a serious threat to the function of the involved nervous tissue. The cord cannot tolerate rapidly increasing pressure. Concomitant thrombosis of spinal vessels is always a threat also especially in staphylococcal infections and therefore surgical drainage is imperative.

The second type of epidural abscess is a *much more chronic lesion* in some instances even simulating a spinal cord tumor when metastatic or it may occur with a chronic suppurating wound or sinus when secondary to operation or trauma and may be associated with osteomyelitis of the vertebrae.

Case VII represents the first type and constituted a surgical emergency. In this case the organism was a hemolytic streptococcus less locally destructive than the staphylococcus and extremely penicillin sensitive (0.0075 Oxford units). The abscess was not truly a closed wound since partial decompression was maintained through a small drain at one end of the wound. In addition the infection overlaid the less vulnerable cauda equina. For these reasons with careful observation of the progress of the infection an unorthodox policy of radical conservatism was followed and resulted in a very brief morbidity and a minimal scar in place of the usual radical decompressive laminectomy of the entire lumbar cord.

In Case VIII a typical chronic hematogenous epidural abscess the usual adequate surgical decompression and laminectomy were performed. Penicillin greatly shortened the morbidity and permitted a successful secondary closure. Yet the organism was resistant to pen

killed by the in vitro bio-assay beyond the therapeutic level obtainable for penicillin in the human body (4 Oxford units). This illustrates an as yet poorly understood synergism between the penicillin effect and body immunity which is beyond the power of either alone. It is noteworthy that the patient developed mastoiditis while receiving 240 000 units of penicillin daily. Similar peculiar occurrences have been observed, such as the development of acute appendicitis during treatment with the drug.

The difference in response to treatment in Cases IX and X illustrates two important principles of penicillin treatment. First Case X treated in the early days of penicillin received a grossly inadequate dosage over much too short a period (see the table). In the second place although x-ray revealed a small area of osteomyelitis of the fourth lumbar lamina a conservative course was followed in the hope that the new wonder drug would somehow bring about healing. Contrast the result in the almost identical Case IX. On the third day of a vigorous penicillin regimen sequestrectomy with removal of necrotic lamina and facet was carried out. The postoperative course was smooth and final healing occurred the forty first day after the start of penicillin whereas final healing did not occur in Case X until about the one hundred and fortieth day. Had we been employing secondary closure at the time Case IX was under our care we might have shortened the course still more. In the penicillin treatment of osteomyelitis of the flat bones whether in the skull, spine or pelvis a combination of vigorous dosage (at least 25 000 units intramuscularly every three hours) and early adequate surgery has in our hands invariably halted the destructive process and a short morbidity has been the rule. Until the osteomyelitic bone is removed however it seems to perpetuate bone necrosis in spite of massive penicillin dosage.

CASE VIII—Diagnosis Hematogenous epidural abscess simulating cord tumor

On September 9 1941 one month following the drainage of an acute staphylococcal otitis media this twenty three year-old hitherto private underwent laminectomy from the fifth to eleventh dorsal vertebra inclusive with the uncovering of a huge extradural abscess. Culture revealed hemolytic *Staphylococcus aureus*, coagulase positive resistant to over 4 Oxford units of penicillin.

Penicillin, both by the intramuscular route and locally by periodic instillations through a Dakin's tube was given from September 20 to November. The parenteral dosage was at first 40 000 units a day but this was gradually reduced to 10 000 units. The total amount given was 620 000 units over thirty six days. Because of several days of unexplained fever the mold was discontinued from October 8 to 15. The fever promptly abated and did not recur when penicillin was started again. Whether this was a coincidence or an actual instance of penicillin fever is not certain.

The patient's course was remarkably smooth. On September 2 he developed a left acute nonsuppurative mastoiditis from which at operation, *Staphylococcus aureus* was cultured. Unfortunately the penicillin resistance of this organism was not determined. The laminectomy wound had progressed so well by October 19 that on this date secondary closure of the wound was carried out with com-

plete success. Final healing occurred November 1 and a final check up February 15 1944 revealed a well patient free of all residual symptoms other than some stiffness of the back. The patient was returned to duty March 3 1944.

TRAUMATIC MENINGITIS

Before the advent of the sulfonamides recovery in traumatic meningitis was rare. Adequate dosage of sulfadiazine greatly improved the outlook of the disease. The present two cases VI and VII are especially noteworthy in that the meninges were sterilized by administration of penicillin in both cases after sulfonamide therapy had failed to achieve this result. As has been shown by others parenteral administration of penicillin has been of little or no avail in treating meningitis whereas injection by the intraspinal intracisternal and intraventricular routes has been life saving. As demonstrated by Rammelkamp and Keefer¹ and others as well as by our own observations even the largest parenteral injections of penicillin produce no detectable trace in the spinal fluid. On the contrary it was shown experimentally by Pilcher² and is dramatically shown in the case report below that complete sterilization of the meninges may be effected by intrathecal administration alone. As to the proper site of injection the lumbar route is the simplest and safest and should be used routinely. This was confirmed theoretically by our laboratory studies in one case which showed no significant difference in penicillin assay of the spinal fluid specimen taken from cisternal or lumbar level whether the previous injection had been given intraspinally or intracisternally. Yet it is suggestive that in Case VI reported below clinical improvement and lowering of cell count were achieved by intracisternal injection while progress was static during treatment by the lumbar route.

Although the *optimum dosage and frequency of administration* have not been definitely established our findings correspond with that of other workers in that twenty four hours following an intraspinal injection of 10 000 units there is still a therapeutic level of penicillin present (0.3 to 5 Oxford units with the average over 1.5 units). However Case VI improved on two daily doses of penicillin after beginning to lose ground on single daily doses. Our policy except in desperately ill cases is to start off with 10 000 to 15 000 units daily. If the patient does poorly on this the dose is given every twelve hours.

The normal flow of cerebrospinal fluid may prevent penicillin introduced in the lumbar subarachnoid space from reaching the ventricle. Case VII reported elsewhere⁴ showed no penicillin level in the ventricular fluid just two hours after the introduction of 7500 units by lumbar puncture. The ventricular fluid of Case V showed no trace of penicillin twenty four hours after the administration of 10 000 units of penicillin intraspinally. Therefore if a patient fails to progress on daily or twice daily penicillin injections by the lumbar or cisternal route the possibility of an inadequately treated ependymitis should

lead to serious consideration of ventricular puncture. It is characteristic of traumatic meningitis that it is prone to recur through reinfection unless the avenue of infection is surgically closed. It is preferable to perform surgical repair during a period of remission. However frequently as is illustrated by Case VI below the surgical repair may be successfully achieved even during a flare up of the infection. Needless to say this procedure is rendered far less hazardous if the intrathecal space is flooded with penicillin.

CASE VI—Diagnosis Traumatic meningitis with recurrent self infection

This twenty five year old private in the Military Police was admitted to Walter Reed General Hospital May 14 1944 following an injury in a fist fight. He was disoriented on admission but cooperative. Examination revealed a conscious

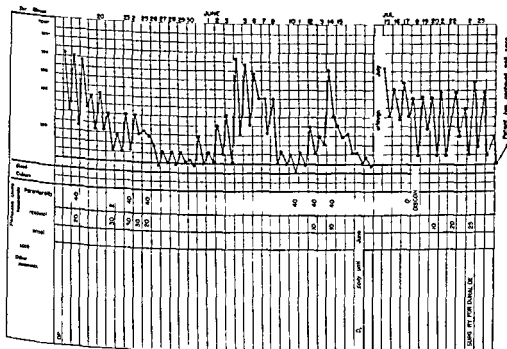


Fig 497—Graphic penicillin chart of Case VI

patient of medium build with muddled intellect. There was ecchymosis about the left eye and the left nostril was filled with blood. The left ear drum was discolored and the neurologic examination was negative. He was treated conservatively and because of evidence of blood behind the left ear drum and an inflamed throat he was given sulfadiazine. On the following day drowsiness persisted and he became progressively more disoriented and restless. The pulse fell to 50 with an increase in pulse pressure the blood pressure being 155/70. The temperature rose to 10.6 F. In spite of the absence of any localizing neurologic symptoms it was felt that the rapidly increasing signs of intracranial pressure probably indicated an extradural or acute subdural hematoma. A bilateral trephine was done and cloudy subarachnoid fluid was encountered. This was cultured and pneumococcus Type IV recovered.

The patient was started on 30,000 units of penicillin intramuscularly every three hours. A lumbar puncture was done the following day and a pressure of

130 mm of water recorded with 11,000 U's all of which were polymorph nuclear. Ten thousand units of penicillin were injected intrathecally at this time and this dosage was repeated later in the day. Twenty thousand units were given in this manner daily for five days. Thus it was increased to 15,000 units twice daily for three days and the patient appeared clinically fully with cerebrospinal fluid penicillin was reduced to 10,000 units once daily for two more days. Intrathecal administration was then suspended but the intramuscular penicillin was continued as was oral sulfadiazine. The spinal fluid became clear and the patient ambulatory (See Fig. 49). One week later however in spite of full doses of penicillin and sulfadiazine the meningitis recurred and the patient developed fever, nuchal rigidity, photophobia, headache and the spinal fluid was ground glass in appearance. The patient was again started on penicillin intrathecally (10,000 units daily) for ten days. When progress became retarded in intrathecal injections semel in re effect. During this time the sulfadiazine was withheld but 30,000 units of penicillin intramuscularly were continued every three hours.

After two weeks of further observation as an ambulatory patient a convalescent furlough was allowed. On the second day after arriving home the patient suddenly developed chill, fever, vomiting, headache and stiffness of the neck. He returned to the hospital, planned to be examined and examination showed photophobia, nuchal rigidity and temperature of 103° F. Lumbar puncture revealed turbid fluid. Intrathecal penicillin was started again for a third course but this time without the aid of the drug intramuscularly or without sulfonamide therapy. On two occasions when the symptoms and increasing cell count suggested delayed progress, central injection were done. Eight days after onset of this relapse a left subtemporal craniotomy with removal of a focal lesion over the posterior portion of the temporal bone was carried out. The spinal fluid became crystal clear with the disappearance of all symptoms.

SUMMARY

1 Twelve cases of surgical infections of the central nervous system treated by penicillin are presented. These include six brain abscesses, four epidural abscesses and two cases of traumatic meningitis.

2 Only one patient in this series died although two others have not yet been discharged from the hospital.

3 These satisfactory results were achieved by combining adequate surgery with penicillin therapy and the absolute necessity for the former must not be overlooked.

4 In brain abscess it has been found that parenteral penicillin is life saving in the early cerebritis stage in localizing this diffuse process to allow surgical drainage.

5 In the established abscess parenteral penicillin has no effect other than prophylaxis against spread during drainage.

6 Adequate local injection of penicillin into the abscess may sterilize it.

7 The unique case of the cure of a brain abscess secondary to lung abscess is presented.

8 The intrathecal use of penicillin in traumatic meningitis is strikingly effective whereas its parenteral use is of no demonstrable benefit.

9 Dosages and routes of administration are discussed.

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TREATMENT OF WOUNDS OF THE BLADDER AND URETHRA

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WOUNDS of the urinary bladder occur either by penetration or rupture. Bullets, pieces of shrapnel, splinters of wood or glass or fragments of bone perforate the viscus. Rupture results from sudden increase in intravesical pressure caused by abrupt compression from external violence. Rupture occurs only when the bladder is distended; perforation can occur when the bladder is practically empty.

DIAGNOSIS

Symptoms of rupture of the bladder are of little clinical significance. Shock and the multiplicity of injuries that frequently accompany bladder trauma mask the symptoms. Localized suprapubic pain is usually present but is also noted after fracture of the symphysis pubis and after trauma to the abdominal wall. Acute onset of abdominal pain centered around the umbilicus may signify rupture of the urinary bladder or of any other abdominal viscus. Passage of bloody urine is significant of injury to some part of the urinary tract. Patients with partial rupture of the bladder or a tympanaded bladder wound may pass bloody urine but the patient with a complete bladder rupture cannot void at all. When rupture of the bladder or posterior urethra is suspected the patient should not be encouraged to void lest he empty the contents of the bladder into the peritoneal cavity or into the perivesical or periurethral tissues.

Signs of rupture of the bladder or urethra should be systematically evaluated. By inspection perforating wounds are noted. Palpation of the urethra in the penile and perineal portions and of the scrotum must be carefully done to rule out extravasation of blood or urine. Blood without urine at the external meatus indicates rupture of the urethra external to the external sphincter. Suprapubic tenderness, ecchymosis, mass or crepitus may suggest fracture of the pubic ramus or rupture of the bladder. Extravasation of blood or urine in the perineum or in the perianal region may mean rupture of the membranous or prostatic urethra.

Digital rectal examination should be routine when rupture of the bladder or urethra is suspected. Normally the membranous urethra can be palpated as a longitudinal cord between the anal sphincter and the prostatic apex because it lies against the pubic symphysis. In

From the Urological Section, Walter Reed General Hospital, Washington, D. C.

rupture of the membranous urethra the fossa on either side of the membranous urethra is obliterated and the prostate apex is dislocated. When complete rupture of the urethra occurs in this area the prostate may not be felt and the space is filled with blood or extravasated urine. It is frequently easier to palpate the bladder by rectum than suprapubically.

When *extrusion of urine* occurs after rupture of the bladder or urethra it follows well established fascial planes. An excellent description has been published by Culp.¹ After rupture of the anterior urethra extravasation is limited by the fascia of the penis from there it may pass beneath the tunica dartos of the scrotum beneath Colles' fascia of the perineum or upward over the abdomen beneath Scarpa's fascia. I have drained urine from beneath Scarpa's fascia over the flanks after rupture of the bulbar urethra. Urine cannot extravasate down the thighs because of fascial attachments at Poupert's ligament. Because of the attachment of Colles' fascia to the urogenital diaphragm urine cannot extravasate into the perianal region after rupture of the anterior urethra.

Rupture of the membranous urethra results in extravasation between the layers of the urogenital diaphragm. From this confined area it usually breaks through the superior layer and passes in front of the prostate into the prevesical space. From rupture of the prostatic urethra urine usually escapes into the ischiorectal fossa on one side or the other by tears through the layers of the fascia of Denonvillier.

Rupture of the bladder is complicated by extravasation either into the peritoneal cavity or into the prevesical space dependent on whether the rupture occurs at site of peritoneal attachment. If penetration occurs when the bladder is quite empty peritoneal perforation is the rule. However anterior bladder rupture is most common and the peritoneum may not be injured especially when the injury occurs on a full bladder.

The passage of a *diagnostic catheter* is a most useful procedure. When rupture of the urethra or bladder is suspected a soft rubber or Nelaton catheter may be gently passed. Failure of the passage of this soft instrument should be checked by careful rectal examination. If the membranous or prostatic urethra is torn the instrument will hang in that area and the tip may be felt by rectum. If the catheter passes with ease the urethra is probably intact. If clear urine is obtained one can be fairly sure that no injury to the urinary tract has occurred. If bloody urine under pressure is obtained the bladder is not ruptured and one must look in the upper urinary tract for the damage. When no urine or blood is found rupture of the bladder is quite certain. The passage of the diagnostic catheter must be preceded by accurate palpation of the bladder. I have seen the passage of the diagnostic catheter to be followed by drainage of 1000 cc. of slightly bloody urine. There were no signs to suspect rupture of either kid-

ney therefore cystoscopy was done. An intraperitoneal rupture of the bladder was noted. The catheter was passed into the peritoneal cavity and the extravasated content drained.

Injection of a contrast medium into the bladder for diagnosis of rupture is unnecessary. Only on rare occasions in the male and rarely in the female is cystoscopy indicated. When in doubt it is safer to explore and drain the bladder. The scalpel is the safest emergency instrument.

TREATMENT

Treatment of rupture of the bladder or urethra is based on four principles: (1) drainage (for prevention or treatment of extravasation), (2) hemostasis (by packing or suture), (3) diversion of the urinary stream (cystostomy), (4) repair of the defect (suture).

When the question of extravasation is in doubt, drain and divert the urine by cystostomy. The use of the urethral catheter is contraindicated in these cases.

Defects of the bladder outside the peritoneal cavity may be sutured. Defects opening into the peritoneal cavity must be sutured. It is not usually necessary to drain the peritoneal cavity after the extravasated urine has been evacuated.

Perforating Wound of the Bladder Complicated by Injury of the Lower End of the Ureter—This injury is infrequent but is of considerable interest as in the following case:

A twenty-year-old soldier wounded on April 3, 1943 by a machine gun bullet had the wound of entrance just above the greater trochanter of the left femur and the wound of exit 6 cm. above the right trochanter. The missile perforated the rectum, the urinary bladder, severed the right ureter near the bladder, and injured the sciatic nerve. Debridement of the wound was carried out. At laparotomy two sigmoid perforations and one of the ileum were sutured. Two bladder perforations were closed and the urine was diverted by cystostomy. He was sent to a evacuation hospital and then to a station hospital where the suprapubic tube was removed on May 10, 1943. Following removal to a general hospital on May 14, 1943, he developed intestinal obstruction and the diagnosis of ileocolonic fistula was made. The suprapubic tube was removed and a transverse colostomy was performed. He was sent to the Zone of the Interior and was admitted to Walter Reed General Hospital on September 16, 1943. On examination urine from the left kidney was draining through the cystostomy and urine from the right kidney drained from the wound over the right hip. He had a fistulodrop on the right but the major part of the sciatic nerve was uninjured. The colostomy was functioning well. Intravenous uricograms showed a moderate right hydronephrosis with dilatation of the ureter down to a point near the bladder.

On October 12, 1943, a right ureterocystostomy was performed through a right lower quadrant muscle cutting incision. The ureter was readily exposed on the surface of the peritoneum and freed to the scar near the bladder. The cut end of the ureter was dissected from the fistulous tract which communicated with the wound in the

Right hip Anastomosis was carried out by a method very similar to the usual technic of ureterosigmoidostomy. The bladder was perforated with an Halsted clamp at a point of fixation to the scar. A mattress suture of No. 1 chromic catgut was placed in the tip of the ureter which had been cut obliquely. The two ends of the suture were placed on two Mayo needles passed through the cystostomy opening together and brought out 3 cm. below the perforation to place 3 cm. of ureter inside the bladder. Three chromic catgut sutures were used to fasten the ureteral wall to the outer bladder wall. The wound was closed with drainage.

Intravenous urograms six weeks after operation showed that the hydronephrosis had been relieved and the kidney was functioning normally. On December 3, 1943, the wounds of the hips which communicated with each other and with the old suprapubic wound were excised and large amounts of scar tissue were excised. The bladder wounds had healed and the patient was voiding all urine through the urethra normally. On January 4, 1944, the colostomy was closed.

Rupture of the Membranous Urethra—Repair of the defect after rupture of the membranous urethra by anastomosis of the severed ends is best carried out at the time of the initial operation if the condition of the patient permits. Immediate suture reduces scarring and resultant stricture formation. Many urologists have treated such cases by cystostomy and have depended on traction on a Foley bag catheter to draw the ends of the urethra together. The catheter is introduced through the anterior urethra grasped with forceps as it emerges through the triangular ligament threaded into the prostatic urethra and drawn into the bladder. The balloon is inflated and traction made on the catheter emerging through the anterior urethra. This has proved satisfactory in many instances; however, I have seen several severe strictures after such treatment which have been difficult to dilate. It is sometimes possible to suture the prostatic apex to the triangular ligament suprapubically using two or three sutures of chromic gut placed by the aid of the boomcrang needle in the depths of the wound.

For the urologist trained in the perineal approach the repair of the ruptured membranous urethra either immediate or delayed is relatively easy. I have had to do the operation described by Young² in seven instances after the initial operation of suprapubic cystostomy had been done in emergency and the patient evacuated to the zone of the interior for further surgery.

The classical perineal approach is used. An inverted U incision is made in the perineum with the apex 3 cm. anterior to the anal margin. The wings extended backward toward the tuberosities of the ischia. The ischiorectal fossae are developed by blunt dissection to expose the midline perineal structures. With a sound in the anterior urethra held as a guide the fingers may be passed across the midline behind

the transversus perinei muscles in front of the rectum and posterior to the sound in the membranous urethra. The perineal body may then be divided over the finger. The recto urethralis muscle is then isolated by blunt dissection. These fibers are variable and are a conjunction of the fibers of the transversus perinei muscles and the fibers of the levator ani muscles as they meet in the midline and join with the fibers of the longitudinal muscle of the rectum. If care is taken in the isolation of these fibers and they are sharply divided away from the rectum there is no danger of injury to the rectum. The prostatic apex may be seen after division of the recto urethralis muscle.

A sound passed from the suprapubic wound into the prostatic urethra may be used to press the prostatic apex into position for suture to the anterior end of the divided urethra. Four sutures of No. 1 chromic catgut suffice. The wound is drained to prevent localized infection and a 24 or 26 F catheter is fastened into the urethra as a splint. I do not leave this catheter in place more than ten days. Dilatation of the urethra is then carried out every fourth day using filiforms and followers until the wounds are healed. Then patients may require periodic urethral dilatation after they leave the hospital.

The results following this operation have been completely satisfactory in six cases. In the seventh we have encountered a complication of serious consequence.

A twenty seven year old sergeant in the infantry while on duty in the Southwest Pacific suffered a crushing injury of the pelvis and amputation of his left leg at the thigh with severe crushing injury of the abdominal contents and rupture of the bladder and membranous urethra when an ammunition truck overturned. The patient was treated effectively for shock, his leg was amputated by the guillotine method, his bladder was drained suprapubically and he was sent to the nearest evacuation hospital. Here an attempt was made to unite the ends of the urethra by passage of a catheter after sounds passed antegrade and retrograde had met in the region of the prostatic apex. With this catheter in place cystostomy drainage was maintained for some time but when the suprapubic tube was removed no drainage of urine occurred through the urethral catheter.

This soldier was admitted to Walter Reed General Hospital during a suprapubic tube three months after his initial injury. The urethral catheter was in place but drained no urine. On his arrival the cystostomy wound was dilated to allow introduction of the examining finger into the bladder. The urethral catheter did not pass through the prostatic urethra but entered the suprapubic wound through the space of Petzrus. X-rays showed the catheter passing to the left of the midline and lateral to the prostate where it could be palpated by rectum.

Under sodium pentothal anesthesia cystoscopy was carried out by passing the panendoscope through the cystostomy opening. Filiforms and catheters were admitted through the vesical orifice but could not pass for more than 2 cm. The cystoscope was removed and an attempt was made to pass sounds through the prostatic urethra retrograde to meet a sound passed antegrade. The maneuver failed.

On July 20, 1944 the operation as described by Young was done through

the penneum. There was no difficulty in anastomosing the prostatic apex with the torn end of the membranous urethra. Drainage was established in the prevesical space from which considerable granulation tissue was curetted. A No. 24 Foley bag catheter was used as an urethral splint.

Nine days after operation a periurethral abscess at the penoscrotal juncture was drained. On the tenth day a severe secondary hemorrhage occurred which required packing of the prevesical space and the perineum. At that time the sutures in the perineum had sloughed out and there was a 2-cm defect in the urethra at the prostatic apex. This was resutured on the eighteenth day when there was slight hemorrhage from the perineum. Traction was made on the Foley bag to relieve strain on the suture line.

Twenty three days after operation the patient had another severe hemorrhage which required opening of the suprapubic wound, packing of the prevesical space and packing of the perineum and the area of the periurethral abscess. There was severe sepsis of the entire wound. To obtain hemostasis the defective membranous urethra was again sutured. Severe secondary hemorrhage on the thirty-seventh day after two weeks of cessation of all bleeding required packing of the entire area in front of the prostate and urethra.

It is possible that repair was undertaken too soon after the initial operation and that infection would have played a lesser role if we had allowed the prevesical wound to heal before attempting repair of the urethral defect. We have learned that severe late secondary hemorrhage is not uncommon in patients who have suffered extensive wounds. I am sure that secondary repair of urethral defects can safely be delayed.

Wounds of the Penile and Bulbar Urethra with Extensive Mucosal Loss
—Wounds of the penile and bulbar urethra which effect loss of large portions of mucosa are very difficult to repair. Such operative work should be delayed until sepsis is negligible and the wounds have contracted as much as they will.

A forty-year-old gunner of a bomber was struck by a 40-mm cannon shell September 27, 1943. Major Herbert Willy Meyers' notes are quoted: "There is a large wound of the anteromedial aspect of the left thigh extending from 10 cm above the knee to the inguinal region, damaging and destroying the muscles of the thigh, the abductor group and the sartorius. The femoral vessels are exposed from Poupart's ligament to the midthigh but are still in their sheath. The skin of the left scrotum is destroyed, the left testicle practically destroyed. The right scrotum is intact. The perineum is extensively damaged. There is a strand of tissue 8 cm long and 1 cm wide attached to the root of the penis and showing some urethral mucosa. The entire urethra is divided from the exposed prostate in the bulbous portion of the corpus spongiosum. The entire perineal body is destroyed. The skin around the anus is completely avulsed from the anal canal. There is a wound of the right buttock continuous with the perineal wound from which there is a steady oozing of blood. This wound leads along the descending ramus of the pubis and ischium to the posterior aspect of the neck of the femur where a large metallic foreign body can be felt. The inferior pubic ramus and the ischium are fractured. Many loose pieces of bone are in the tract."

A rapid colostomy was done through a McBurney incision. The peritoneum was not sutured. A rubber catheter was placed under the loop for support and the external oblique fascia was closed above and below the loop. Suprapubic

the transversus perinei muscles in front of the rectum and posterior to the sound in the membranous urethra. The perineal body may then be divided over the finger. The recto urethralis muscle is then isolated by blunt dissection. These fibers are variable and are a conjunction of the fibers of the transversus perinei muscles and the fibers of the levator ani muscles as they meet in the midline and join with the fibers of the longitudinal muscle of the rectum. If care is taken in the isolation of these fibers and they are sharply divided away from the rectum there is no danger of injury to the rectum. The prostatic apex may be seen after division of the recto urethralis muscle.

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of the bladder into the peritoneal cavity must be sutured. Other bladder wounds should be sutured if possible. Ruptures of the membranous urethra are best sutured at the time of injury. If this is impossible sufficient time should elapse to allow infection to subside before repair is undertaken.

The perineal approach to the membranous urethra is described.

Complicated cases of wounds of the bladder and ureter, membranous urethra and the anterior urethra are reported.

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of shock and stabilization of the patient's condition are necessary before one can even determine whether radical surgical intervention is indicated. In this connection it is important to emphasize that one feature peculiar to thoracic wounds namely partial suffocation may be a major factor in producing shock when the lungs are damaged. This may result from blood or secretions accumulating in the trachea or bronchi or may result from hemorrhage or edema in the pulmonary parenchyma. One or both of these factors combined with the anoxemia of shock may prove fatal. Bronchial secretions or blood clots may often be removed successfully by aspiration through a bronchoscope or by catheter suction. A lung drowned with blood or edema fluid is a more serious problem and oxygen therapy is probably the most satisfactory form of treatment. It is extremely important therefore to consider the possibility of partial suffocation before evaluating the patient's condition and particularly before attempting any major surgical procedure.

Practically all surgeons agree that if possible operations in the forward areas should be confined to closure of sucking wounds, control of external hemorrhage and relief of tension pneumothorax. Edwards and Davies have stated: "To open the thorax wide in the presence of shock in order to deal with hemorrhage may occasionally bring off a brilliant success but it will almost certainly kill many patients who otherwise would have recovered." Few surgeons actively engaged in war surgery will disagree with this statement.

Two important points in the initial treatment of chest wounds which have received particular attention during this war deserve mention: (1) The management of sucking wounds (2) Relief of pain originating in the chest wall.

Sucking Wounds.—A defect in the chest wall is usually apparent and if there is any possibility of an opening into the chest wall the wounded man's clothing should be removed in order that the chest wall can be carefully inspected. The absolute necessity for prompt closure of sucking wounds was understood during the last war and has been repeatedly emphasized in discussions of thoracic injuries for many years. It is true of course that openings larger than the trachea are more dangerous than smaller defects. The consequences of a sucking wound however will depend upon the vital capacity of the wounded man. For example a small opening in the chest wall may easily be fatal in a patient whose vital capacity has been materially reduced by hemorrhage into the lung or pleura. The principle of immediate closure of sucking wounds in the chest has been substantiated by experiences in this war. Communications from the front however indicate that under adverse conditions precluding proper cleansing of the wound, the methods of closure should be altered depending upon the condition of the wound.

Nicholson and Scadding³ report a high incidence of infections of

the chest wall when sucking wounds were tightly sutured. They suggest firm suture of deeper layers of the chest wall and loose closure of the skin over a paraffin pack. This technic in their opinion is the best solution for sealing an open pneumothorax while at the same time providing drainage of the chest wall wound. In emergency conditions occlusive dressings may be utilized as a temporary measure if primary suture is unwise because of the condition of the wound. It is important to emphasize that regardless of the technic employed the physiologic bellows like action of the chest wall must be preserved as much as possible to insure respiratory exchange. Whether this is done by tight sutures of all layers of the chest wall, delayed primary sutures or by occlusive dressing will depend upon the wound and the available surgical facilities.

Pain Originating in the Chest Wall—Pain in the chest wall is important not only because of the suffering it may cause but because reflex splinting of the movements of the thoracic cage as a result of the pain will further diminish vital capacity. Pain resulting from minor rib fractures common in civil life can often be controlled by partial immobilization of the chest wall by properly placed adhesive strapping. The more effectual the immobilization of the thoracic cage, however, the more the reduction in vital capacity, and in the severely wounded a strapping that is tight enough to relieve the pain satisfactorily may reduce respiratory excursions to a dangerous level. For this reason there has been an increasing tendency to avoid chest strapping if possible. The use of novocain injections to relieve pain deserves consideration.

Novocain Blocks for Relief of Chest Wall Pain—Experienced surgeons near the front have found the injection of novocain either in the site of rib fractures or by paravertebral block to be highly successful in controlling pain. Samson⁴ and Burford⁵ have employed paravertebral blocks in severely wounded men with gratifying success. They emphasized the necessity of relieving pain and shock in patients with thoracic wounds before an intelligent evaluation of the case can be made.

Paravertebral block is ordinarily a simple procedure which can be carried out with a minimum amount of equipment. The following technic has been employed by Mousel⁶ at Walter Reed General Hospital.

Technic of Paravertebral Block—Paravertebral block may be done with the patient lying in the prone position or with him on his side with the thighs flexed on the abdomen. If the prone position is employed a large pillow should be placed under the abdomen to flex the vertebral column as much as possible. After proper skin preparation an intradermal wheal of novocain is placed 3 cm. lateral to the interspace between the posterior spines of the vertebrae at the desired level. The position of the wheal is slightly caudad to the lateral spin

ous process of the vertebra represented by the posterior spine only slightly below this level. This position is necessary because the posterior spines of the dorsal vertebrae extend caudally to overlap the vertebra below. After the intradermal wheel has been raised a 3 inch 26-gauge needle is passed through the skin and is advanced slightly upward and medially until the transverse process of the vertebra has been located. The needle is then slightly withdrawn and the tip of the needle is redirected below the transverse process. After the tip of the needle slides under the lower border of the transverse process it is advanced approximately 0.5 cm. Paresthesia can usually be elicited at this point. After paresthesia has been obtained the syringe is attached to the needle and the plunger of the syringe is withdrawn in order to make sure that the tip of the needle is not lying within the subarachnoid space or has not passed into an artery or a vein. Five cubic centimeters of 1 per cent solution of procaine hydrochloride or metycaine is now injected. The initial injection is of course performed at the level to which pain has been localized. It is well to remember that if paravertebral block is to be employed for thoracotomy, at least two intercostal nerves must be blocked below and above the level of the operative incision. This is also a good working rule when using paravertebral block to relieve pain originating in the chest wall.

TRAUMATIC HEMOTHORAX

Experience in the management of hemothorax cases has emphasized the differences between war wounds and penetrating wounds of the chest commonly seen in civil practice. It is becoming more and more apparent that the conservative treatment of hemothorax by allowing the blood to absorb should not be followed unless the hemothorax is very small. Tudor, Edwards,⁷ Roberts and Tubbs,⁸ Nicholson and Scadding³ have all found that the policy of early aspiration preferably without air replacement seems to give the best results.

Immediate Treatment of Hemothorax.—The immediate treatment is of course directed toward the *control of hemorrhage and shock*. Transfusions of blood are usually necessary in severe wounds and autotransfusions of blood aspirated from the pleura may be employed if compatible blood is not available. Griswold and Orner⁹ have employed autotransfusions in 100 cases with one fatal reaction from the transfusion. The death was the result of faulty technic in filtering the blood. They stress the necessity of rigid filtration technic when reinfusion is contemplated. Countless lives have been saved by blood plasma during the present conflict but it is important to remember that blood transfusions furnish the most effectual method for the prevention and treatment of shock.

Immediate aspiration is of course necessary if the volume of the blood is causing respiratory embarrassment.

Linberg and Acutin¹ express their views as follows. It is their opinion that there is no valid argument in favor of leaving blood in the pleural cavity except for the theoretical danger of secondary hemorrhage, an extremely rare complication. They ridicule the suggestion that infection is introduced by aspiration and conclude that if this occurs it is a criticism of the technic rather than of the principle. One notable exception among surgeons actively engaged in war surgery is Goldman¹³ who apparently has found that spontaneous absorption of pleural blood occurred in many of his cases. He suggests that aspiration of the fluid should be reserved for cases showing pressure symptoms or in cases where infection is suspected. The other extreme is Holmes¹⁴ views which are mentioned only to condemn them. He advocates immediate exploratory thoracotomy in all types of pleural and pulmonary wounds. Most experienced surgeons however believe that this radical policy would result in many unnecessary operations and probably would substantially increase the mortality of thoracic wounds.

Accumulated data from various surgeons with wide experience in the treatment of war wounds indicate that the following general routine has been employed successfully in the treatment of initial traumatic hemothorax. Aspiration of the blood is begun about twenty-four to forty-eight hours after injury provided the patient's condition does not preclude the performance of thoracentesis. The volume of blood to be aspirated will be determined by the patient's reaction. The complaint of tightness in the chest indicates that the intrapleural pressure is too negative for the patient's comfort. Nicholson and Scadding³ have mentioned that the patient's sensation is a perfectly reliable guide to the safe level of pleural pressure and this has also been our experience. If the tight feeling in the chest is severe a small amount of air may be introduced to relieve the increasing negative pressures. Air replacement however will seldom be necessary if the patient has been warned to state when he begins to feel uncomfortable. Thoracentesis should be performed daily or on alternate days and continued until the pleura is emptied. The amount of blood which can be removed in the individual case and the number of aspirations will of course be variable depending upon the size of the hemothorax. In our experience from 500 to 750 cc of fluid can usually be removed at each aspiration.

The fear that repeated aspirations increase the chances of infection has little justification. Not only does the early re-expansion of the lungs prevent a large empyema but the retention of the blood in the pleura increases greatly the incidence of sepsis.

Chemotherapy in the Treatment of Hemothorax—Several British surgeons report that the routine use of *sulfanilamide* by mouth in patients with chest wounds exerted a favorable influence on the incidence of hemolytic streptococcal infections. Tudor Edwards¹⁵ advocates the

biacrole because of the rather high incidence of Staphylococcus infections in chest wounds. The benefits of the local sulfonamide derivatives in chest wounds is difficult to evaluate. The ability of penicillin to remain potent in the presence of pus and the success with this agent in the sterilization of cavities however indicates that it will be extremely useful when used locally in the treatment of hemothorax both as a prophylactic or as a therapeutic agent if infection has occurred. It is important to remember however that even if the contents of a wound can be sterilized by a chemical agent the mechanical effect of the re-expansion of the lung remains.

Hemothorax or Fibrothorax—Chronic hemothorax resulting from the formation of a putty like mass bathed in blood is a relatively rare complication of thoracic wounds. Apparently every case of hemothorax will progress to the chronic stage unless the treatment originally employed. It seems reasonable however that delay in aspiration will favor clotting. While working in the middle East Nicholson and Scadding³ observed that 6 per cent of clotted hemothoraces in their 791 penetrations of the chest. These authors are of the opinion that this is not an important factor since half of their cases were cured and half were not. They conclude however that the degree of delay has an important influence on the clotting of blood in the chest. It is interesting that Smith¹² of Charleston South Carolina reported fifty cases of hemothorax and hemopneumothorax in his clinical files and found also an incidence of 6 per cent of chronic persistent hemothoraces in various types of wounds occurring in civil life. In our series of 175 cases of gunshot wounds of the chest the incidence of chronic hemothorax has been approximately 5 per cent. This lower incidence is probably because many patients with chronic hemothorax were treated here and not sent to a chest center in the Zone of

of Chronic Hemothorax—Not only is the lung crippled by its collapse when splinted by an organized clot in the pleura but there is convincing evidence that there is inflammatory response in the pleura and the lung itself to retained blood. Edwards and his associates¹³ studied pleural reactions to blood through a thoracotomy. They observed acute hyperemia, edema, fibrin deposition and in some cases resulted in fibrous attenuation of the entire lung. He believes that concomitant serous pleural effusions in cases of hemothorax are the result of the irritating effect of the blood upon the pleura. Lugonot¹ describes three patients in whom extensive calcification developed from untreated persistent hydrothorax. He states as that the ultimate goal in the treatment of hemothorax is the re-expansion of the lungs and conservation of as much

cardiopulmonary function is possible. The method to be employed in each case will depend upon a number of factors. It would be wrong indeed to subject every patient with a longstanding hemothorax to an open operation. In many instances even when the blood has been present for a prolonged period of time properly performed aspirations will be successful in evacuating the fluid. The common error in aspirating a hemothorax of some duration is that the needle is placed too low and is promptly plugged with fibrin which has settled to the bottom of the cavity and a free flow of fluid is prevented. This may lead to a premature conclusion that the pleura contains an organized clot. Under these circumstances aspiration should be repeated at higher levels and often a smooth flow of fluid will result. By repeating this maneuver at various levels one is often rewarded by a satisfactory re-expansion of the lung in cases which appear at first glance to require a formal thoracotomy. Failure to remove the fluid by repeated aspiration is the most reliable indication for open thoracotomy.

Neither the duration of the hemothorax nor the appearance of roentgenograms of the chest will furnish a reliable clue concerning the necessity of operation for the removal of an organized clot.

Technic of Open Operation in Chronic Hemothorax—If a radical operative procedure is found necessary the thorax should be opened through a large enough incision to insure ample exposure of the entire pleura. It has been our experience that in many cases the clot occupies a posterior position. When this is the case a posterolateral incision has been employed either with resection of a long segment of one rib or by the division of two ribs with the incision carried through the intercostal muscles. The method employed to effect an entry into the chest is not important and will depend upon the preference of the individual surgeon. If the clot is a total one involving almost the entire pleura with complete collapse of the lungs an anterolateral intercostal approach is attractive because the costal cartilages need not be divided and adequate exposure can be obtained by merely inserting the rib spreaders between the cartilages.

Once the pleura is entered the clotted material may be removed manually and the pleural cavity thoroughly irrigated with saline. It is then necessary for the surgeon to decide whether the lung will re-expand satisfactorily after the clot has been removed or whether the corset of fibrous tissue encasing the lung will preclude expansion of the organ. If this is the case a decortication operation is in order. To determine this important point we have employed the following technic. Intratracheal anesthesia has been utilized in all cases of chronic hemothorax. After complete evacuation of the clot and irrigation of the pleura the anesthetist exerts 7 to 10 cm. of water pressure on the lungs through the intratracheal catheter. If this produces free motion of the lungs decortication is not carried out. On the

other hand if the lung remains fixed the corset of fibrous tissue overlying the visceral pleura is removed

One detail of technic remains controversial namely should the pleura in these cases be drained after the operation or should the chest be closed tightly and repeated aspirations be performed to keep the pleura free of accumulations of air and fluid? Smithy¹³ feels that the wound should never be left open unless the hematoma is infected. He condemns even the use of a catheter for drainage because he believes that the pleura is extremely susceptible to infection in the presence of organizing thrombi. Nicholson⁸ however has employed drainage in all of his cases even when the clot is not infected because he feels that to omit drainage would be inviting chronic empyema. We have employed closed catheter drainage in the majority of our cases keeping the pleura free of fluid by constant suction. With local penicillin protection however it seems likely that repeated aspirations might prove satisfactory.

Chronic hemothorax or fibrothorax will rarely be encountered in civil practice. It is important however to record that in persistent cases surgical intervention is usually highly successful and should be carried out before permanent damage to the lung has occurred.

SHELL FRAGMENTS IN THE LUNGS

It is generally agreed that bone splinters bits of clothing and other nonmetallic foreign bodies which may have penetrated the lung should be removed as soon as the patient's condition permits. There is however little reliable information concerning the ultimate damage to the pulmonary parenchyma from the retention of a metallic foreign body such as a bullet or shell fragment. There can be little question that the presence of a sizable metallic foreign body in the lung or pleura will increase the risk of pulmonary sepsis or empyema. It is true that if infection does not develop during the first few months after the injury the most dangerous time has passed. Late complications can and do occur. It is significant that many surgeons with wide experience with gunshot wounds of the chest during the last war had a tendency to adopt a radical attitude concerning the removal of metallic foreign bodies. Operations on the thorax can now be performed with so little danger to the patient that it is probably justifiable to adopt a more radical policy in dealing with shell fragments in the lungs than would have been safe twenty five years ago. This principle however applies only to elective operations after the patient's condition is stabilized. In deciding whether to remove retained shell fragments from the lungs we have endeavored to individualize each case and have considered the following factors: (1) whether the metallic foreign body has produced signs or symptoms; (2) the size and position of the fragment and (3) the psychosomatic effect

upon the patient who is aware that he has a piece of metal in his lung

Hemoptysis as the result of a retained foreign body is a positive indication for operation. Pulmonary sepsis complicated by a retained foreign body likewise demands surgical intervention. In this connection it is well to remember that exploration of the chest and removal of a foreign body before infection has developed usually gives a

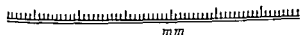


Fig 493—Upper Roentgenogram showing large shell fragment in the lungs. There were no symptoms from the foreign body but it was removed because of its large size. Lower Photograph of shell fragment after removal.

speedy recovery and excellent results whereas the late treatment of a pulmonary abscess complicated by a retained foreign body is accompanied by grave risk. Pain is a difficult symptom to evaluate in deciding whether to remove a foreign body from the lung or leave it alone. Probably in most instances the pain originates in the damaged chest wall and has no connection with the metallic fragment in the thoracic viscera.

Size and Position of the Fragment—Some surgeons advocate removal of foreign bodies larger than 2 by 2 cm. Others adopt a more radical attitude and recommend the removal of any metallic foreign body larger than a pea. Nicholson and Scadding³ are of the opinion that foreign bodies in the periphery of the lung least often cause trouble and if complications such as abscess or hemoptysis arise later the condition can be treated with less difficulty than if the foreign body is in a deeper position. They believe that central foreign bodies or those near the mediastinum are far more dangerous and if left alone until complications occur surgical intervention will be hazardous.

It is safe to say that size alone is probably not a reliable criterion on which to base the decision to remove a metallic foreign body. Obviously, the large shell fragments should be removed provided trained surgeons and adequate equipment are available (Fig. 493). If a man has survived the immediate effects of a gunshot wound neither the size nor position of the fragment in the lung will make it necessary to perform an emergency operation for the removal of the foreign body. It is safe to conclude however that the substantial number of late complications which may be expected will justify the removal of all sizable foreign bodies as soon as the patient's condition is stabilized.

Psychosomatic Effects upon the Patient—Many men are disturbed by the knowledge that they have a shell fragment or fragments in their lungs. It is interesting that the same patient with a large metallic foreign body in his thigh and a smaller one in his lung parenchyma will become lung conscious and have a tendency to forget his other wound. This is not a modern phenomenon but was described during the American Civil War by Otis.¹⁸ Reassurance by the surgeon that the pulmonary wound will not give him trouble sometimes diverts his attention. In a borderline case however it is impossible to guarantee honestly that the patient is immune from late complications. Vigor, pains, shortness of breath and other subjective symptoms commonly develop. If the foreign body is good sized and these manifestations persist removal of the shell fragment is recommended in our clinic.

The Removal of Bullets and Shell Fragments from the Lungs—Localization—The ease with which a metallic foreign body can be removed from the lung depends largely upon precise preoperative localization. The three dimensional concept of the thorax which can be gained by carefully prepared frontal and lateral projections on the x-ray will usually localize a radiopaque foreign body satisfactorily. The frontal projection will establish the position of the fragment in relationship to ribs which can be counted and identified upon the patient. The lateral view will furnish a reasonably accurate idea of its position in relationship to the anterior and posterior chest walls. A third film

taken in the lateral decubitus position exactly duplicate the position of the patient on the operating table is also helpful (Fig. 494). It is our custom to first examine the patient with the fluoroscope and mark with a metallic marker the position of the retained shell fragment in relationship to the chest wall. The three x-ray projections which have just been described are then obtained and the location of the metallic marker checked by the findings on the roentgenograms.

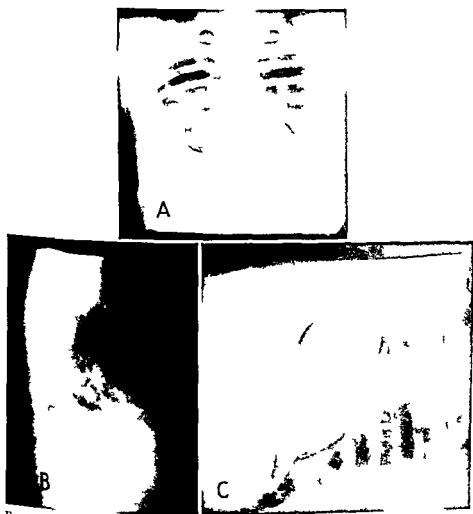


Fig. 494.—The three essential x-ray projections for the localization of a metallic foreign body in the chest. *A* Frontal projection. *B* Lateral projection. *C* Lateral decubitus. This view duplicates the position of the patient on the operating table.

The Berman localizer which has been developed under the direction of Dr. John Moorhead is extremely helpful in locating metallic foreign bodies in the thorax when they are near the periphery of the lung or in the chest wall. With the aid of this instrument it is often possible to avoid a rib resection and wide incision of the pleura. The position of the foreign body can be determined before the pleura

is opened and a small intercostal incision employed in suitable cases. The level of the skin incision however will usually depend upon roentgenographic findings.

Anesthesia—The elective removal of a shell fragment from the lung should not be undertaken unless facilities for anesthetic technics which will control intrapulmonic pressures are available. Intratracheal administration of the anesthetic agent insures stable intrapulmonic pressures and a means for aspirating the trachea and bronchi if necessary. A tight fitting face mask may control pressure satisfactorily but lacks the other advantages of intratracheal technic. The wide margin of safety with ether vapor recommends it as the anesthetic agent of choice.

Operative Technique—The fundamental surgical principle of adequate exposure is particularly important when removing foreign bodies from the lungs. The skin and muscle incisions should be wide enough to allow access to at least two interspaces when the bony thoracic cage is exposed. The initial incision into the pleura however should be small. If precise localization has been accomplished and the lung is adherent it is sometimes possible to avoid opening into the free pleural space. When the foreign body is deeply embedded in the pulmonary parenchyma however the opening into the pleura must be large enough to allow palpation and adequate exposure of the lung. In uncomplicated cases wide excision of lung tissue or total lobectomy is not necessary when dealing with foreign bodies. The lung tissue can be incised, the fragment removed and the raw surface of the lung repaired with a few sutures of fine chromic catgut. With penicillin protection we have had no difficulty with secondary infections when this principle is employed. When the complications of empyema or lung abscess are present it will of course be necessary to maintain drainage after the foreign body is removed.

SUMMARY

1 Accumulated evidence from thoracic surgeons in the forward areas of battle indicate that the initial treatment of thoracic wounds should be conservative if possible.

2 Paravertebral novocain blocks have proved to be extremely valuable in the early treatment of thoracic wounds.

3 There is an increased tendency among thoracic surgeons to treat traumatic hemothorax by early aspiration avoiding air replacement. Early and complete re expansion of the lung is important in preventing late complications of thoracic wounds and in some instances permanent damage to the lung may occur if hemothorax fluid is allowed to remain in the pleura.

4 Chronic hemothorax should be treated by open thoracostomy and decortication of the lung if necessary. Once it is apparent that

the organized clot cannot be evacuated by aspiration with syringe and needle surgical intervention should be recommended

The surgical principles involved in the management of shell fragments in the lungs are reviewed

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SUPERVOLTAGE (ONE MILLION VOLT) ROENTGEN THERAPY AT WALTER REED GENERAL HOSPITAL

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CANCER in the young is uncommon. The annual cancer death rate per 100 000 population for the age group twenty to twenty four years is 5.1 and for the age group twenty five to thirty four years is 10. However, when cancer patients are sifted from many million service men and women and concentrated in a few hospitals they constitute an important problem in these centers. For example at Walter Reed General Hospital 31 per cent of the autopsies are performed on patients with malignant tumors. Thirty three per cent of the surgical pathologic specimens sent to the laboratory for histologic examination are concerned with the diagnosis of neoplasm. Of these 9 per cent are proved to be cancer. The daily census of hospital patients receiving radium or roentgen therapy ranges from 100 to 125 exclusive of a large number of outpatients.

Because of the relatively young average age of the military population the distribution of the types of tumors is unbalanced as compared with the distribution found in civilian tumor centers.

Thus in order of frequency during the past two years there have been over 200 cases of malignant lymphoma chiefly Hodgkin's disease almost 100 cases of carcinoma of the testis many cases of bone tumor soft tissue sarcoma carcinoma of the skin and lip brain tumor non nevoid hemangioma mediastinal tumors of various types and carcinoma of the head and neck especially the nasopharynx.

Radiation or surgical therapy is administered under ideal circumstances. Each cancer patient is mandatorily reviewed by a Tumor Board composed of the chiefs of the Surgical Laboratory and Radiation Therapy services. The fourth man on the board is the ward officer of the respective service from which the patient comes. This four man board has proved to be more efficient than a larger one. The patient being hospitalized during his entire stay is under constant supervision. He is usually young and strong and can tolerate the large dosages of roentgen or radium rays that are necessary. There are few complications such as arteriosclerosis and nephritis which might necessitate a compromise reduction in the intensity and quantity of the therapy given.

From the Radiation Therapy Section Walter Reed General Hospital Washington D C

Originally in the Radiation Therapy Department deep roentgen therapy was administered only by x rays activated at 200 kilovolts. This was attended by certain disadvantages. It was often necessary to administer large amounts of radiation producing severe skin reactions which occasionally either failed to heal or after primary healing might break down months or years later requiring extensive surgical repair. In addition there still remained numerous lesions which were

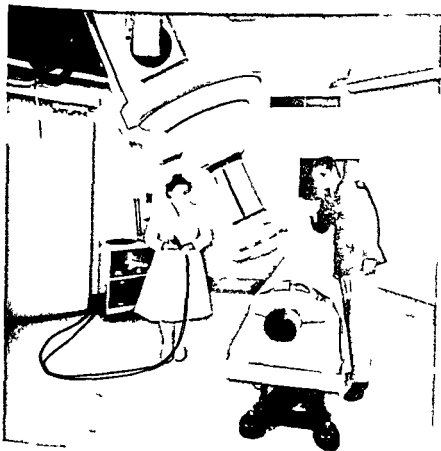


Fig 493.—Tube head of million volt machine containing x ray tube and transformer partly descending down the ceiling well. All motions are controlled by the multiple switch in the hands of the nurse. Accessory light beam illuminating the treatment field assists in aiming of the beam of x rays.

so situated that in spite of cross firing with multiple beams of roentgen rays it was impossible to deliver a lethal dose to the tumor. In order to improve the efficiency of roentgen therapy a million volt apparatus was installed in February 1944. There were at this time approximately fifteen other million volt machines of varied designs in the United States. The machine at Walter Reed is the smallest and most compact and has the unique characteristic of being as flexible and mobile as any modern 200 kv machine. These features

were developed under the stimulus of the accelerated evolutionary program necessitated by the war effort for use in industrial roentgenography

The outstanding characteristics of the new design are resonating transformer permanently evacuated and sealed off x ray tube which eliminate the cumbersome continuous evacuation pump and the placement of tube and transformer in a tank filled with freon gas under

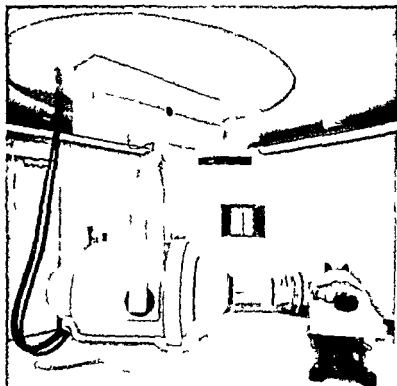


Fig. 496—Another position that the tube can occupy

60 pounds pressure which serves both as a cooling and insulating medium. This permitted reduction in size of the apparatus and construction of a compact unit which could be maneuvered in all directions.

The disadvantages of previous designs were the size of the apparatus and the fixed position of the x ray tube which protruded from the ceiling or side wall into the treatment room. The patient had to be adjusted to the tube, a cumbersome procedure. It was exceedingly difficult to cross fire a tumor with multiple beams of radiation directed at different angles.

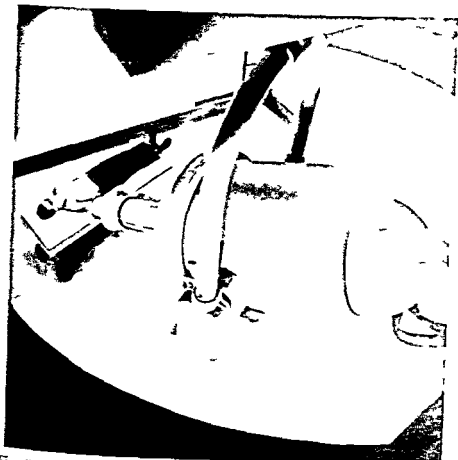


Fig 49—View of tube head taken from the well in the second story

COMPARATIVE EFFECTS OF SUPERVOLTAGE (1000 KV) VERSUS HIGH VOLTAGE (20 KV)

When a beam of roentgen rays traverses tissue it produces secondary electrons. These electrons are stopped by atomic units in the cells, and as a result energy is set free. This energy disrupts atomic chemical, chromosomal and other biologic activities resulting in destruction of cells and tissue. The speed of the secondary electrons is dependent upon the voltage. If the voltage is very high, the electrons will have such great speed that they will travel a considerable distance from the point of impact before they have slowed down to their optimum speed for interaction with atomic units in the cells. Superficial therapy (100 kv) produces relatively slow electrons which are readily absorbed in tissues adjacent to the point of impact and converted to destructive effect. Hence, only a small amount of radiation (300 roentgens measured with scattering) is required to produce a skin erythema. Radiation with 200 kv produces secondary electrons of greater speed and a smaller proportion of these electrons is stopped in the superficial layers of the skin. Hence 510 roentgens (measured with scattering) are required to produce an erythema.

Supervoltage (1000 kv) produces secondary electrons of such tremendous speed that 1000 roentgens are required to produce an erythema. The significance of the above facts is that with higher voltage less radiation is absorbed in the superficial layers of the skin. There is less skin damage and consequently a larger amount of radiation can be delivered through each skin portal.

From the practical clinical viewpoint the mild skin reactions produced by million volt roentgen therapy is important. Modern roentgen therapy entails the administration of such large doses of radiation as to produce severe second degree and occasionally third degree skin reactions. This is particularly true in the treatment of carcinoma of the upper respiratory tract with the Coutard technic carcinoma of the breast certain sarcomas and other lesions. These skin reactions often fail to heal or if they heal primarily may break down and ulcerate months and years later. Extensive plastic surgical repair may be required. With supervoltage roentgen rays the skin reactions are seldom more intense than a first degree erythema. They produce very little discomfort to the patient during their greatest intensity and probably will not require surgical repair. This one feature alone almost validates the increased cost of supervoltage roentgen therapy.

Supervoltage roentgen rays will deliver a larger amount of destructive rays to the deeper tissues. This may on occasion produce undesirable damage to adjacent normal tissues. These increased depth effects on normal tissues are manifested by severe reaction in the mucous membrane of the mouth and throat resulting in prolonged duration of the radiation induced pseudodiphtheritic membrane causing difficulty in swallowing. Similar membranes are produced in the bladder, vagina and rectum when the pelvis is heavily irradiated resulting in cystitis with frequency and painful urination, diarrhea and painful proctitis. Months later there may be seen telangiectasia and contraction of the bladder mucosa, chronic pelvic rectal fibrosis secondarily involving the rectum or an indurated intrinsic rectal ulcer or late intestinal injury manifested histologically by destruction of the epithelium, atrophy and replacement fibrosis. These undesirable effects are seldom severe and in any event are outweighed by the increased destruction of the tumor.

Still another advantage of supervoltage (1000 kv) stems from the different behavior of the secondary electrons. When ordinary high voltage (200 kv) radiation is used to treat a deep seated tumor such as carcinoma of the cervix there occur in the tumor two types of radiation: primary radiation from the direct beam of roentgen rays and secondary radiation scattered into the tumor when the primary beam has struck nearby atoms of normal tissue. If a narrow beam of rays is employed having a diameter slightly larger than the tumor itself the amount of radiation that reaches the tumor is inefficiently small and there is very little secondary radiation. Hence it

The treatment with 200 kv of a typical case of *carcinoma of the tonsil* according to Courard's principles would entail the administration over a period of approximately twenty five days of a dose of 4000 roentgens (measured with scattering) to each of two lateral neck portals cross firing the tumor. There would result a severe second degree skin reaction with denudation of the skin in the irradiated area requiring three to four weeks to heal. In addition there would be an intense second degree mucous membrane reaction with denudation and an extensive pseudodiphtheritic membrane in the pharynx and larynx also requiring three to four weeks to heal. These reactions would cause considerable discomfort and debility. The healing of the skin reaction may be attended by late fibrosis and telangiectasia. However when supervoltage (1000 kv) is employed a smaller dose of 3600 roentgens (measured with scattering) to each of two lateral neck portals may be employed. This will produce only a mild first degree erythema of the skin which causes little or no discomfort to the patient and a comparatively severe second or even third degree mucous membrane reaction because of the greater depth dose delivered to the tumor bearing area and the adjacent normal mucous membrane. In view of the fact that in the past the severe skin reaction from 200 kv irradiation has limited the total exposure to an amount which was often sublethal in its effect on the tumor the ability to deliver larger quantities of radiation to the skin and an even proportionately greater dose to the depth establishes million volt roentgen rays as the preferable type of treatment of carcinoma of the tonsil.

Carcinoma of the nasopharynx requires a lethal tumor dose of approximately 6000 roentgens. When 200 kv radiation is used it is possible to deliver 4000 roentgens (measured with scattering) to each of four small face portals (4 by 5 cm) cross firing the tumor. This exposure will deliver a dose in the tumor of approximately 5000 roentgens. This dose is generally sublethal in its effect and must be supplemented with radium. However when 1000 kv radiation is employed and the same dose of 4000 roentgens is administered to each of four portals a dose of 9000 roentgens is delivered to the tumor itself. As explained above when small portals are used the superiority of supervoltage over usual high voltage is almost twice as great. In an increased percentage of cases of carcinoma of the nasopharynx it therefore becomes unnecessary to employ supplementary radium.

In *carcinoma of the cervix* external irradiation with 200 kv contributes moderate benefit to the eradication of the primary tumor and metastatic nodes. Using 1000 kv the clinical shrinkage of the tumor is often striking. One is tempted in some instances when the patient is slim and the tumor radiosensitive to eliminate radium altogether because of the occasional apparent complete destruction of

the primary tumor with external radiation alone. One patient had a moderately differentiated carcinoma of the cervix with infiltration of the broad ligament and metastasis to a lateral pelvic node. This node grew at an accelerated pace forming a mass 12 cm in diameter. The usual intra uterine tandem and vaginal corks were supplemented with six long radium needles inserted into the base of the broad ligament and the pelvic mass. There was very little shrinkage of the pelvic mass. Subsequently through three portals (anterior lateral and posterior) it was possible to deliver a dose of 7000 roentgens into the center of the lateral pelvic mass. The mass apparently disappeared completely six months ago and there have been no skin or intestinal sequelae. This is another instance of a radio-incurable lesion becoming radiocurable.

There is a definite indication for million volt therapy in the treatment of radiosensitive tumors. *Hodgkin's disease* and *lymphosarcoma* frequently require a lethal tumor dose of 2500 to 3000 roentgens. When the lesions are deeply situated in the mediastinum or retroperitoneal area it is difficult to apply the lethal tumor dose with 700 kv radiation without producing severe skin reactions and radiation sickness and utilizing multiple portals to cross fire the tumor. When million volt roentgen rays are employed, the lethal tumor dose can be administered in fewer treatments through fewer skin portals with less intense skin reaction and radiation sickness.

The successful treatment of *seminoma of the testis* is dependent upon intensive postoperative irradiation of the retroperitoneal lymph node bearing area extending from the lower pelvis up to the retrogastric node. The lethal tumor dose of this lesion is 1000 roentgens delivered in approximately one week. However the retroperitoneal nodes occupy such an extensive region require so many treatment portals and are so deeply situated that they receive only a small percentage of the irradiation delivered to the skin. It takes seven to eight weeks to deliver the necessary amount of radiation. Consequently since the daily increment of radiation to the node is small and since the prolonged period of irradiation permits the tumor to recover in part from the effects of irradiation, a compensatory increase of the lethal tumor dose up to 2000-2500 roentgens becomes necessary. Such a tumor dose can only be administered with 700 kv radiation in limited individuals. In many individuals it is almost impossible to deliver the necessary lethal dose to the retroperitoneal region. On the other hand when supervoltage (1000 kv) is employed it is a simple matter to administer 3000 and even 4000 roentgens to the node. Furthermore the lethal tumor dose can be delivered in approximately one half the length of time. This means that the compensatory increase in tumor dose necessitated by the increased duration of the treatments need not be as great. For example the necessary radiation can often be

delivered over a period of one month and the compensatory increase in the lethal tumor dose desired might feasibly be 1700 to 2000 roentgens

The above figures obtain with seminoma of the testis which comprises one half the malignant tumors of the testis. When dealing with *embryonal carcinoma* with slight differentiation the average lethal tumor dose must be increased 50 to 75 per cent. It is impossible to effectively irradiate retroperitoneal nodes of this tumor with 200 kv radiation. Million volt therapy is mandatory.

SUMMARY AND CONCLUSIONS

Million volt roentgen ray therapy has reached the stage where certain conclusions concerning its superiority over lower voltage radiation can be stated.

- 1 It produces more effective destruction of the tumor by virtue of the greater quantity of effective radiation that can be delivered to the tumor with each treatment. As a consequence the total number of treatments and the duration of the course of treatments is materially reduced.

- 2 The relatively mild immediate and late skin reactions reduce the discomfort to the patient and permit the administration of larger quantities of radiation through the skin. The increased depth dose to the tumor is attended by an increased incidence of damage to adjacent normal tissue. This is a calculated risk which is outweighed by the beneficial effects on the tumor.

- 3 A number of lesions which were formerly considered radioincurable may now be considered as radiocurable.

- 4 A number of lesions which were efficiently treated with 60 kv radiation can be more efficiently and effectively treated with 1000 kv radiation.

AMPUTATIONS A COMPARISON OF END BEARING AND ORDINARY STUMPS

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The rehabilitation of the amputee can be described as (1) obtaining the best possible painless stump (2) fitting a satisfactory prosthesis and teaching the amputee to use it and (3) establishing the amputee in a useful occupation in which his disability does not interfere with his earning capacity

In this paper we will restrict our discussion largely to the stump with a few remarks about fitting as the two cannot be entirely separated. In certain countries where the care of amputees is dominated by the limb fitters the stumps most commonly seen and those recommended are the ones easiest to fit. In England a very special type of specialist has been developed called a limb fitting surgeon. He is not a surgeon as he does not operate and he is not a limb fitter as he does not manufacture and apply prostheses. He is actually an advisor and very critical inspector. There is a very definite need for this advice and inspection but it seems preferable that the surgeon who cares for amputees should be capable of fashioning a stump to fit a prosthesis and also of seeing that the prosthesis fits the stump.

The main difference in amputation experience in this war as compared to the last is that there have been many fewer thigh amputations and many more through the foot and leg. The reasons for this are (1) The extensive use of land mines has caused many severe foot and leg injuries. (2) The use of plasma and blood has saved the lives of many injured who without these shock combating fluids would never have left the battlefield. (3) The control of infections (especially gas gangrene) by sulfa drugs and penicillin has largely eliminated the necessity for the midthigh amputation as a life saving measure.

Amputation in the forward battle area should be a simple debridement of an extensive compound wound discarding that part of the extremity which has no circulation or can never perform useful function. The use of the conservative guillotine amputation in the forward zone has made it possible for us to obtain longer and more satisfactory stumps than those previously achieved by primary closure. The fashioning of permanent stumps and fitting these stumps with prostheses is being done in specialized Amputation Centers in the Zone of the Interior where all the facilities for fitting artificial limbs are available.

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not fit the end of the femur and produces a small rounded surface on the end of the stump rather than a flat one. In many instances the patella fails to unite with the femur and frequently it becomes displaced and has to be removed (Fig. 498).

It is especially helpful in a *bilateral* amputation to have one stump which is truly end bearing. The patient frequently will stand on this end bearing stump whenever he is stationary and spare the below knee or thigh stump which has to take side bearing or ischial bearing. The surgeon naturally attempts to save the knee if possible but this is not advisable if a satisfactory below knee stump cannot be obtained (Case VI). It has even become necessary to fit some of these very short below knee stumps with the knee flexed as when the old type of peg leg was used many years ago. These patients can bear full weight just as they would in the kneeling position and the stump gives much less trouble than it would in a below knee bucket but we do not advise this as a routine procedure. Patients with bilateral thigh amputations always have a great deal of trouble in learning to walk and stairs are an almost insurmountable difficulty. We have however seen several such patients with end bearing stumps who have succeeded in learning to walk on full length prostheses. Those who have lost so much of their extremities that short thigh stumps or midthigh stumps are all that can be obtained must usually begin walking on pylons and many of these cases spend most of their lives in wheel chairs (Case VII Fig. 505).

PRESENTATION OF CASES

CASE I—A thirty six year-old private in the infantry was admitted March 8 1944 because of a right below knee amputation and loss of all the toes of the left foot. This man was older than the average soldier and looked older than his given age. He had not had some trouble in the calves of his legs for several years especially after kneeling or squatting down. From December 4 to 8 1943 he was out in the cold and rain constantly removing his shoes only once during this period. He was admitted to an overseas general hospital with typical trench foot. On December 22 1943 a midleg amputation was performed on the right leg and on December 7 1943 all the toes of the left foot were debrided.

On admission to the Amputation Center the right leg stump as well healed and ready for fitting but the anterior end of the left foot was an unhealed ulcer surrounded by thin glistering scar. This ulcer healed very slowly in spite of physiotherapy sympathetic blocks and typhoid inoculations. When the patient began to walk the scar promptly broke open again. On September 5 1944 a lumbar sympathectomy was performed by Colonel F. A. Crist. The circulation of the foot was greatly improved by this procedure and it is expected that the ulcer will remain healed. The next fitting is required (See Fig. 499).

In this patient enough of the weight bearing skin and other structures remained to make it worth while to use any amount of time and trouble to save the foot.



Fig. 499 (Case I) —Trench foot. Loss of all the toes with ulceration of the anterior end of the foot. Weight bearing skin has been saved

CASE II —A private in the infantry was admitted to the Amputation Center July 1, 1943 with bilateral Syme amputations. He had sustained compound

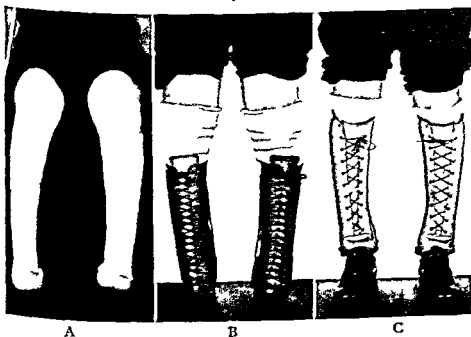


Fig. 500 (Case II) —A Good bilateral Syme stumps B Temporary prostheses for Syme stumps C Permanent type prostheses.

fractures of both feet as a result of enemy shellfire near Oran on November 8 1941. A bilateral Syme amputation had been performed on the same day by a French surgeon. One stump healed per primam while the other drained slightly for several months. He had already been fitted with temporary appliances upon which he walked very well. He was even able to walk on the ends of these stumps without any prostheses. Permanent Syme prostheses were fitted and the patient was discharged. (See I & 500 A B C)

Although this patient did not walk any better than the ordinary bilateral below knee amputee he could stand or walk for long periods without any fatigue or discomfort.

CASE III—A twenty-one year-old private in the field artillery was admitted on February 6 1944 with a below knee amputation on the right side and a



Fig 401 (Case III)—A Below knee stump right and Syme stump left. A good combination for a bilateral case. B Patient walking with prostheses.

loss of the anterior half of the left foot as a result of a shell explosion at Salerno on September 13 1943. On March 1944 the right leg was reamputated 6 inches below the knee and a typical Syme amputation was performed on the left foot. Both stumps were completely healed in ninety days. The right below knee prosthesis was fitted six weeks after amputation and a temporary peg applied to the Syme stump. On July 4 1944 a permanent type prosthesis was applied to the Syme stump.

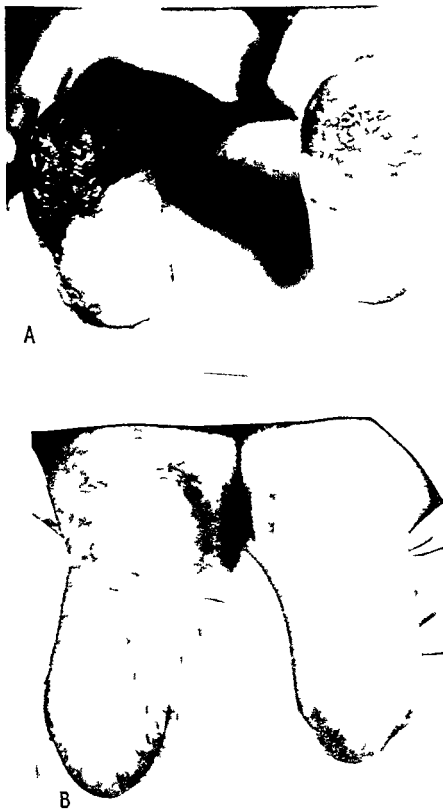


FIG 50* (Case IV) — *A* Exposure and frostbite. *B* So much of the feet and plantar skin has been lost that ideal below knee stumps are the best that can be done.

On August 7 the patient went on one month's furlough. Upon his return he stated that both stumps were satisfactory but that he was glad not to have to wear any contraption above his knee on the left side. His only complaint was that the leather corset of the right below knee prosthesis was rubbing against the scar on the back of his right thigh. (See Fig. 501.)

In this case the comfort and stability of full end bearing on the Syme amputation and the fact that the prosthesis laces on like a boot ending at the knee are contrasted with the discomfort which occurs so frequently in the ordinary below knee stump due to friction on the skin in the bucket or in the thigh corset.

CASE IV—A second lieutenant in the air forces was admitted on May 9, 1944, having suffered a severe frostbite of both feet. On January 5, 1944, his plane had crashed in France and the French underground had smuggled him to northern France. The Lyonnais together with three other aviators in the trip over the mountains the local guides made these men walk night and day even though the roads were in very bad condition. On arrival in Spain all three had severe frostbite of both feet. One lost all of his toes, another lost most of each forefoot and part of both heels. But in this case it was considered possible by plastic procedures to obtain useful weight bearing feet. The patient reported he had lost so much of the weight bearing skin of the feet that it was thought best to perform bilateral malleolus amputations at the site of election. This was done on June 8, 1944. The patient was fitted with artificial legs nine weeks later. (See Fig. 502, A, B.)

Because of the complete loss of the heel skin the Syme amputation could not be used in this case.

CASE V—On admission in December 1943 the patient had a well healed below knee stump on the left side. On the right side the stump was short below knee as still and there was no possibility of obtaining a satisfactory below knee stump. Supracondylar tendoneuroplasty amputation was done on December 16, 1943. The wound healed rapidly. The patient was fitted with prostheses on February 10, 1944. At the time of discharge on March 30, 1944, he was considered one of the best walkers among the bilateral amputees. He was able to stand for indefinite periods bearing his entire weight on the right supracondylar stump. The left knee was very useful to him in getting up from a sitting position and climbing up and down stairs. (See Fig. 503, A, B.)

This case illustrates that in a bilateral amputation one good strong end bearing stump is a real advantage.

CASE VI—A private in the medical corps, nineteen years of age, received a traumatic amputation of both legs just below the knees with wounds of the hands, face, abdominal wall and left eye when an oxygen tank which he was rolling along the ground exploded on August 8, 1943. On admission to the Amputation Center on November 26, 1943, the right below knee stump was open and was draining foul smelling pus. On the left side there was a 2-inch below knee stump but the entire end and sides were covered with a mixture of skin grafts and keloid scar tissue.

On December 30, 1943, a right supracondylar tendoneuroplasty amputation was performed. The patient was given sulfadiazole before and after operation. The

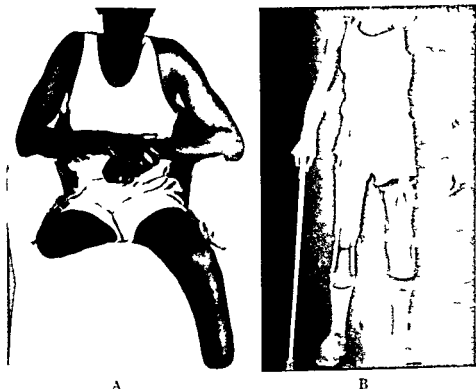


Fig 503 (Case V) — *A* Tendinoplastic end bearing thigh stump right ordinary below knee stump left *B* Patient with prostheses applied

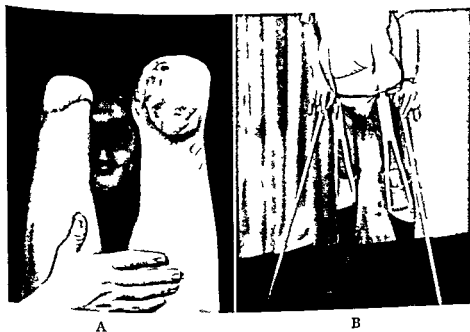


Fig 504 (Case VI) — *A* Good tendinoplastic stump on the right side with a short below knee stump covered with skin grafts and keloid *B* Standing with prostheses after supracondylar amputation

stump healed per primam and the stitches were removed on the thirteenth post-operative day. On February 25, 1944, an end-bearing prosthesis was fitted to the right thigh stump and a special telescopic knee prosthesis with a long thigh cuff

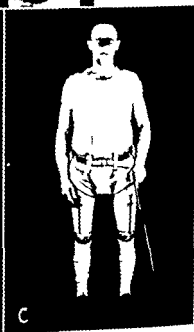
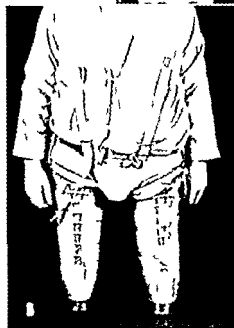
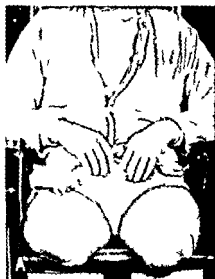


Fig 505 (Case VII)—A Midthigh stumps B Patient walking on pylons C Patient standing on regular ischial bearing legs. These were made 2 inches shorter than his own legs were in order to make balancing easier.

providing some ischial bearing was fitted to the left leg. For one month numerous attempts were made by the patient to use his artificial limb, but the left below-knee stump continued to break down whenever the leg was applied. A

series of lumbar sympathetic blocks did not prevent the ulcer from occurring on the scarred and grafted area.

On April 1944 a supracondylar tendinoplastic stump was performed on the left side. This also healed per primam and the patient was discharged on the seventeenth day. As so frequently happens with bilateral amputations, the patient fell out of a wheel chair and severely bruised the right thigh stump. This delayed fitting of the prostheses until June 1944. The patient has now been walking well for approximately two months. He can go up and down stairs if they are not too steep. He complains not at all of pressure on the stump ends. (See Figure 104 A B).

This case shows that it is useless to try to retain a shoeable knee stump covered with scar or skin graft even in a bilateral case where retention of one useful knee joint is so helpful.

CASE VII—This twenty-six year-old private first class was admitted to the Amputation Center on September 4, 1943. He had sustained a severe crushing injury of both lower extremities on March 14, 1943. A right thigh amputation was done immediately and it was found necessary to do a left thigh amputation March 19, 1943 because of gangrene. On admission the right thigh stump was healed but the left stump showed extensive osteomyelitis with sequestra in the end of the femur. Sequestrectomy was done on the left stump on September 11, 1943. Revision of the right stump was done October 8, 1943. On December 9, 1943, excision of scar and plastic closure was performed on the left thigh. On May 9, 1944, a periosteal spur was removed from the left femur. Later on July 1, 1944, a small slightly painful scar was removed from the right stump. The patient began walking with pylons in February, 1944, and used ordinary full length prostheses in March, 1944. He gets around fairly well but has considerable difficulty in getting up from a chair or climbing up and down stairs. (See Figure 50: A B C).

CONCLUSIONS

- 1 It is recognized that the great majority of amputations in the lower extremities will be in the midleg or in the midthigh.
- 2 The fact that the majority of amputations are at these sites producing stumps that are fairly easy to fit is no justification for not using end bearing when it can be obtained.
- 3 The Syme amputation is probably the best amputation in the lower extremity but unfortunately it can seldom be used because the skin of the heel is so rarely left intact.
- 4 The supracondylar tendinoplastic stump is superior to any other thigh stump because it can withstand full end bearing over prolonged periods and gives a much better control of the prosthesis because of its length.
- 5 Because of the practical superiority of the Syme stump over the ordinary below knee stump—and of the supracondylar tendinoplastic stump over the ordinary thigh stump—the advantage of these end bearing stumps should not be denied to our patients merely because the prostheses required are more difficult to manufacture and are less realistic in appearance.

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THE MANAGEMENT OF THE HEAD INJURY PATIENT

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SINCE the onset of the present war the management of acute head injuries and their sequelae has been accepted with increasing confidence and understanding. Our knowledge of the underlying physiological and pathological factors involved in intracranial injury has grown steadily. The number of complications due to infection has been considerably reduced by local and systemic chemotherapy.¹ New methods for the plastic repair of scalp and skull defects have been introduced.^{4, 5, 13} Human fibrin foam has found a wide application in the control of profuse bleeding from the brain and dural sinuses.⁸ Fibrin film is in use for the repair of dural defects and the prevention of meningocerebral adhesions.⁹ Considerable attention has been focused on the reconditioning of patients with disturbances of speech locomotion sensation coordination and other phenomena resulting from brain damage.

It is beyond the scope of this presentation to attempt a survey of the pertinent literature. Excellent reviews of the subject have been published recently by Martin¹¹ and Merritt.¹ Outlined in this report are the procedures followed on the neurosurgical service of the National Naval Medical Center in the treatment of head injuries and their sequelae. It is emphasized that the greater number of cases coming under our supervision are classifiable as late or reconstruction problems. The number of acute head injuries is no greater than would be treated in any general hospital serving a large community.

MECHANISM OF CONCUSSION AND CONTRECOUP CEREBRAL DAMAGE

No aspects of the head injury problem have received greater attention than the phenomena of concussion and the mechanism of con-

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The opinions or assertions contained herein are the private ones of the writers and are not to be construed as official or reflecting the views of the Navy Department or the Naval Service at large.

contrecoup damage to the brain. The understanding of these phenomena is of utmost importance in the intelligent treatment of head injuries.

Concussion has been defined by Denny Brown and Puell¹ as a direct traumatic paralysis of nervous function without vascular lesion and persists for varying periods according to the type and severity of the injury. The concussive state can be correctly termed the common denominator of all head injuries with loss of consciousness. Fracture of the skull, meningeal and intracerebral hemorrhage and gross cerebral damage are conditions superimposed on concussion.

Although the pathophysiological phenomena that underlie concussion are in large part obscure, much light has been shed on the problem by recent investigations. Denny Brown and Russell² have stressed the importance of acceleration and deceleration of the head in the experimental production of concussion. On the other hand, Gurdjian and Webster³ concluded from their experiments that the important factors are the intensity and duration of the blow irrespective of whether the head is fixed or allowed to move. Evidence is also accumulating that the traumatic stupor following head injury must be a low level lesion that is involving the hypothalamus and brain stem.¹⁰ Physiological and pathological changes in nerve cell groups of the cerebral hemispheres and brain stem resulting from concussive blows have been demonstrated in experimental animals.^{6, 7}

The mechanism of contrecoup damage to the brain appears to be now clearly understood. Utilizing the principles of physics applicable to the movements of masses, Holbourn⁸ has postulated that a blow to the head causes rotation of the brain in a combination of its horizontal, sagittal and coronal planes. The pattern of rotation depends on the site and direction of the blow. The relative fixation of the prefrontal and temporal lobes of the brain by the anterior and middle fossae of the skull gives rise to shear strains that tear blood vessels and lacerate nervous tissue in these areas. This is in accord with the actual gross pathological finding in fatal cases of head injury. We have been able to confirm the rotatory movements of the cerebral hemispheres by means of high speed cinematographic studies of the brains of monkeys exposed through a lucite calvarium.¹¹

EXAMINATION OF THE HEAD INJURY PATIENT

Although a patient with an acute head injury requires emergency treatment, it is seldom that a careful examination cannot be done. The results of this early observation may prove invaluable as a basis for later decisions.

A record should be made of the state of consciousness, size and reactions of the pupils, degree of motor power and the activity of the reflexes. The pulse and respiratory rates and the blood pressure should be taken at thirty minute intervals and charted graphically. The

rectal temperature should be taken at least every half hour because as shock is controlled the temperature may rise rapidly and reach damaging levels.

Associated injuries must not be overlooked. Fractures of long bones may contribute greatly to the degree of shock. Chest injuries may cause cyanosis and dyspnea. A fractured pelvis may produce severe pain, shock and bladder injury. Catheterization should be done routinely, not only because of possible bladder injury but also to relieve urinary retention. These and other possible systemic injuries should be treated promptly since their presence may prove as serious as the intracranial damage.

EMERGENCY TREATMENT

GENERAL MEASURES

The physiologic effects of an acute head injury are multiple intimately related and progressive. Inadequacy of the airway, poor oxygenation, cerebral anemia, high temperature, cerebral tissue destruction and increased intracranial pressure constitute a serious train of events that must be vigorously combatted from every aspect to prevent a fatal outcome. The degree of skull fracture and the actual amount of brain tissue destroyed at the time of injury may be of less importance than these secondary changes.

Airway—The maintenance of an unobstructed airway is one of the indispensable features of adequate treatment. If neglected, all other supporting measures are thoroughly defeated. It is not unusual for the patients to be admitted with partial pharyngotracheal obstruction due to mucus and blood which is loudly pushed back and forth with each labored respiration.

Partial obstruction in comatose patients frequently occurs if the tongue is allowed to drop back into the pharynx. This can be easily remedied by turning the patient on his side or by inserting a rubber or metal airway through the mouth into the pharynx. Mucus and blood must be removed from the pharynx and trachea by suction, preferably through a soft rubber catheter. This procedure should be repeated at frequent intervals because blood and often spit may continue to gravitate into the trachea from associated pharyngeal injuries.

Occasionally severe head injuries are complicated by mandibular fractures with so much edema and swelling that it is difficult to maintain a satisfactory airway. In addition, these conditions make it impossible to apply and maintain an oxygen mask in the mouth without discomfort to the patient. When confronted with these conditions, we have resorted to tracheotomy, which provides an excellent airway that can be easily kept free from mucus. A mask can be placed directly over tracheotomy opening.

Partial respiratory obstruction allows an increase in the concentration of carbon dioxide which not only further stimulates the respiratory center but also acts as a powerful vasodilating agent. The increased volume of blood within the dilated intracranial vascular bed occupies space already at a premium and results in further elevation of intracranial pressure.

Oxygen—When a free airway has been established oxygen is administered in high concentration. A properly used BLB mask is often life saving. A flow of 6 to 8 liters per minute affords adequate oxygena-

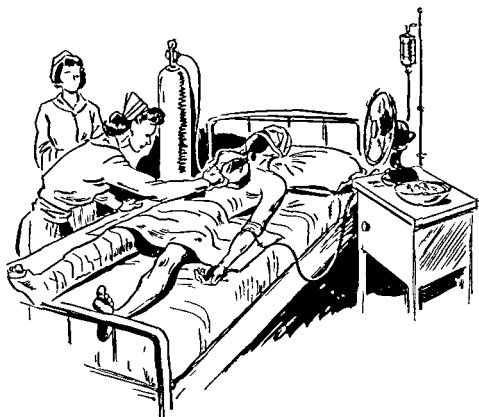


Fig 506—Management of the head injury patient. Control of anoxemia and hyperthermia.

tion of cerebral tissue (Fig 506). In using the mask care must be taken to prevent too much pressure on the chin or pharyngeal obstruction will occur. A tent is not of great value as an emergency measure because the oxygen concentration is low and is further reduced by the frequent opening of the tent to care for the patient. If there is an associated chest injury the patient must not be placed in a position which will compromise adequate oxygenation of the normal lung.

If the cyanosis is not controlled by aspiration of mucus and administration of oxygen a portable roentgenogram of the chest should be

made. This procedure will often disclose an unsuspected pneumothorax or hemothorax. More often a very diffuse mottling of the lung tissue is observed which presumably is the result of aspiration of mucus and spinal fluid. In these cases a frequent change of position, intermittent dependent drainage and blood plasma administration have proved beneficial.

Increased Body Temperature—Negligence in the control of body temperature has resulted in many fatalities. The rectal temperature should be kept below 102° F. Experience has shown that it is much easier to keep the temperature low than to reduce it to a safe level after it has reached 104° to 105° F.

A high body temperature indicates an increased tissue metabolism which requires added oxygen to prevent cellular damage. Although the inadequate airway and the increased intracranial pressure result in poor oxygenation of nerve cells, the brain may be temporarily securing enough oxygen to maintain essential tissue activity. This state of bare equilibrium will continue to exist as long as tissue metabolism is kept at a minimum. However, if the rectal temperature reaches 104° to 105° F. the tissue demands cannot be met and cellular destruction results. Such damage promotes edema and a still greater increase in intracranial pressure. It is obvious that the maintenance of body temperature is an important factor and constitutes one of the major points of attack on the vital cycle of physiological effects which follows intracranial injury.

The situation is analogous to an extremity with a decreased arterial blood supply. Recent experience has shown that tissue destruction can be prevented if the limb is cooled, but gangrene results if it is heated. The reason for this is that a reduced oxygen supply can maintain the tissues if the cell metabolism is reduced. If metabolism is increased by heating the limb, the reduced blood supply is incapable of meeting tissue requirements.

Useful methods for reduction of a high body temperature include alcohol sponges, ice bags, elimination of all clothing and the use of an electric fan (Fig. 506). It is of little value to simply rub the body surface with tepid alcohol. A large basin of alcohol partially filled with ice should be kept in the room. Every fifteen minutes the exposed surface of the body should be thoroughly moistened with the iced alcohol. The alcohol is quickly evaporated by an electric fan allowed to blow directly on the patient. The unconscious patient must be turned frequently so that the back can likewise be cooled. Ice bags placed against the skin of the axilla and groin are helpful.

Control of Intracranial Pressure—The proper methods of controls of increased intracranial pressure have been the subject of controversy among neurosurgeons. Opinion is divided relative to the advisability of lumbar puncture and the value of hypertonic solutions given intravenously.

The majority of neurosurgeons concede that it is of value following severe injuries during which cerebral edema which usually persists for three or four days. It is believed that during this period repeated lumbar puncture and in improving the blood supply to the brain.

It has been our policy to postpone the use of lumbar puncture during the first few hours in order to allow the patient to become stabilized as a result of the conservative treatment mentioned. When the pulse rate is slow (50 to 60) and the respiration is frequently done to determine the exact degree of intracranial pressure. If the pulse rate is improved after the removal of 5 to 10 cc of fluid, the procedure is repeated. Lumbar puncture is contraindicated in those patients with a high pulse rate and deep coma as the signs are probably due to primary brain stem damage rather than increased intracranial pressure.

During the period of recovery lumbar puncture often is beneficial in relieving headaches, meningismus and irritative phenomena resulting from accumulation of blood in the subarachnoid space.

The continuous escape of spinal fluid from the ear, nose or through a compound fracture accomplishes the same result as lumbar puncture in a slower and more physiological manner.

Intravenous hypertonic solutions have been used sparingly. We believe that the rapid fluctuations in intracranial pressure which follow the use of hypertonic solutions of glucose or sucrose tend to make stabilization of the pressure more difficult. However favorable results have occasionally been dramatic during a sudden elevation of pressure not controlled by any other methods. These solutions are not condemned but their use should be reserved for specific occasions when a prompt lowering of pressure is imperative. In our experience serum albumin intravenously for such emergencies has been superior to glucose or sucrose both in degree and duration of the osmotic effect.

X-ray Studies—A careful series of roentgenograms of the skull is an essential part of the examination of every patient with an acute head injury. X-rays should be taken as an emergency procedure when the clinical evidence of rapidly increasing intracranial pressure is compatible with the diagnosis of an extradural hemorrhage. However patients in critical condition due to severe shock should not be rushed to the x-ray department for roentgenograms of the skull until such time as their general condition has been improved by emergency treatment.

Miscellaneous Measures—Concern with the head injury often results in neglect of the essential requirements of *fluid balance* and *nutrition*. These patients cannot be permitted to go long periods without fluids even though one wishes to maintain a sufficient dehydration to control intracranial pressure. At least 1500 cc of fluid should be administered daily in the early period. In warm weather the amount should be in

creased Food is not an urgent matter during the first few days if adequate fluids are given. However if coma persists a Levin tube should be passed into the stomach through the nose and the patient given frequent small feedings of enriched eggnog and fruit juices.

Pestilousness or even extreme degrees of *excitement* are frequently observed in patients following head trauma. This may be due solely to the intracranial damage usually of the frontal lobes but a distended urinary bladder is frequently a contributing cause. Sedation is not contraindicated if the patient is uncontrollable. Paraldehyde by rectum remains the sedative of choice. If the control of excitement is urgent, sodium amytal may be given intravenously.

EMERGENCY OPERATIVE TREATMENT

The conditions associated with head trauma that demand urgent attention are the open wounds with or without involvement of the skull, dura and brain and the massive hemorrhagic lesions. Of the latter complications extradural hemorrhage and rarely profuse subdural or intracerebral hemorrhage are the only real emergencies. If the condition of the patient contraindicates exploration the surgical treatment of most conditions can be delayed.

Anesthesia—Local infiltration of the scalp is the procedure of choice. If the patient is extremely restless intravenous pentothal sodium should be used. However when the surgical procedure is to be extensive with the likelihood of marked blood loss general anesthesia with open drop ether administered through an intratracheal tube is preferable. This permits better control of the patient's respirations through an airway maintained free from obstruction. Oxygen may be necessary and can be administered freely throughout the duration of the surgical procedure. The patient's general condition is always improved during any emergency operation if blood plasma or preferably whole blood is administered routinely.

Scalp Wounds—Lacerations of the scalp associated with head injuries often present a bloody and serious appearance but actually are not of great importance if hemorrhage has been controlled. It has been our policy to limit the emergency treatment of lacerations to

ul shaving, cleansing, inspection of the wound for possible de
I fracture, instillation of sulfanilamide powder and the applica
n of a sterile dressing. We have had no experience with the penicil
lin-sulfanilamide powder mixture advocated recently.³ When the
patient's condition permits the wound is thoroughly scrubbed with
green soap and a sterile brush, the traumatized scalp margins debrided
and a careful approximation done with vertical mattress sutures of
fine tantalum wire.

Depressed Fractures—All depressed fractures should be explored. It is likely that many slightly depressed fragments would cause no
lite symptoms but it is far better surgical judgment to elevate the

depression and remove any comminuted fragments. Compound fractures should have thorough debridement of all foreign material as well as loose bony fragments. Macerated cerebral tissue is removed by gentle irrigation and suction. Lacerations of the dura should be sutured.

Because of its irritative reaction sulfathiazole should never be instilled in any wound with exposed brain tissue. Sulfanilamide can be used locally without fear of reaction. Many prefer only the systemic use of these drugs since the local tissue concentration can be maintained at a sufficiently high level. We prefer the immediate local use of sulfanilamide augmented by sulfadiazine systemically. In time penicillin may replace the sulfonamides in the prevention of local infection but at the present time the limited amount available prohibits its routine use for this purpose.

Intracranial Hemorrhage—The only real surgical emergency associated with an acute head injury is the development of a localized hemorrhage from a lacerated middle meningeal artery. The danger of such an extradural hemorrhage is due to the profuse nature of the bleeding rather than to its location. Hemorrhage from other sources may occur but usually does not demand surgical intervention until a later period. Subarachnoid bleeding may occur from diffuse trauma, subdural hemorrhage from slow venous bleeding and intracerebral accumulations of blood from torn subcortical vessels.

Extradural Hematoma—The classical picture of hemorrhage from the middle meningeal artery or its branches is well known. The history of injury, transient unconsciousness and the lucid interval followed by progressive stupor is diagnostic. Usually there is x-ray evidence of a fracture line crossing the course of the artery. Shift of the pineal body is occasionally noted. A dilated pupil on the same side completes the clinical picture.

Not every patient presents this well defined syndrome and surgical judgment must then be guided by isolated signs. Unilateral dilatation of the pupil, increasing stupor or progressive hemiplegia should always be viewed with suspicion and are sufficient grounds for a trephine exploration. When doubt exists it is far better judgment to carry out a negative exploration than to overlook a developing hematoma. If the cooperation of the patient permits the exploration is done using local infiltration of the scalp. A short hockey stick incision is made and the temporal bone exposed. The hematoma is obvious as soon as the trephine opening is made but usually cannot be adequately evacuated without enlarging the bony opening with rongeurs. After removing the clot the point of bleeding is controlled by ligature or electrocoagulation. If the artery is torn at the foramen spinosum the opening is plugged with bone wax.

If the size of the hematoma in the temporal area is not compatible with the clinical evidence, adjacent areas should be investigated. The

site of hemorrhage most commonly overlooked is in the frontal area either over the frontal pole or beneath the frontal lobe along the roof of the orbit

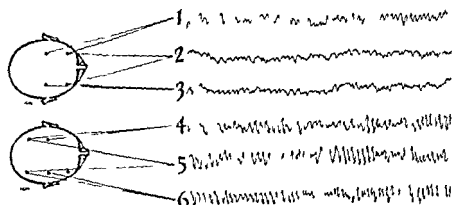


Fig 507—Electroencephalogram demonstrating reduced electrical amplitude associated with a right frontal subdural hematoma

Subdural Hematoma—A progressive accumulation of blood in the subdural space frequently follows head injury. The trauma is usually minimal and not associated with fracture of the skull. Presumably the

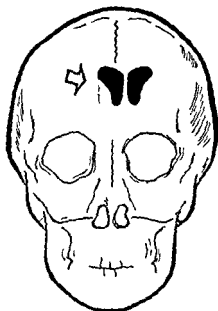


Fig 508—Ventricular shift with right subdural hematoma. Displacement and alteration in contour of ventricles

source of the bleeding is from cortical veins near the midline. Signs of increased intracranial pressure seldom become apparent for some weeks after injury. Frequently the history of trauma is not obtained

and the patient is considered to have a brain tumor. In doubtful cases certain features suggest the presence of a subdural hematoma, namely hemiparesis and/or cortical sensory loss often without hemianopsia and electroencephalogram with a definite unilateral diminution of electrical amplitude (Fig 507) and a pneumoencephalogram or ventriculogram with a shift in the ventricular system but without marked alteration in the shape or size of the ventricles (Fig 508).

Surgical exploration by means of multiple trephine openings is the procedure of choice. It is essential that the frontal, temporal and parietal areas be explored on both sides. Even the presence of a large hematoma on the side first explored does not preclude the necessity of investigating the other side. Bilateral hematomas are common and may even be present when air studies reveal a marked ventricular shift.

Subdural Hydromas—A large collection of cerebrospinal fluid may accumulate in the subdural space subsequent to trauma. Although the pathogenesis of this lesion is unknown, it probably results from a tear in the arachnoid which acts as a ball valve, permitting fluid to pass into but not escape from the subdural space with each pulsation of the brain. It is usually clinically impossible to distinguish this lesion from a subdural hematoma, although it tends to occur at an earlier period following the trauma.

TREATMENT OF COMPLICATIONS OF HEAD INJURIES

The more common sequelae of head injuries which either develop as intermediate or late complications or in which treatment may be delayed are:

1 *Infections*—wound suppuration, osteomyelitis of skull, meningitis, epidural, subdural and intracerebral abscess.

2 *Lesions with loss of substance*—scalp defects, skull defects, cerebrospinal fluid rhinorrhea and otorrhea and the various paralytic phenomena resulting from the destruction of nervous tissue.

3 *Post-traumatic epilepsy*.

INFECTIONS

As a result of the indoctrination of front line medical officers with the techniques of local and systemic chemotherapy, the number of complications of head injury due to infection has been considerably reduced. This is in striking contrast to the high morbidity and mortality rate following similar injury in World War I. At the present time the principal chemotherapeutic weapons are penicillin, sulfadiazine and sulfanilamide in that order of importance. Because of its high solubility, rapid rate of absorption and minimal foreign body reaction, sulfanilamide is the accepted sulfonamide for the prophylactic application to head wounds with or without dural penetration. Sulfadiazine is administered systemically, particularly if the wound involves the

skull and brain or if there is a concurrent cerebrospinal fluid leak. Penicillin is similarly used both locally and systemically.

Wound Infection—Because of its rich blood supply infection of scalp per se is uncommon. This is particularly true if debridement and chemotherapeutic prophylaxis have been carried out. In the presence of frank suppuration the wound is opened enough to establish free drainage and continuous moist saline compresses applied. Sulfanilamide or penicillin is applied locally. The latter may be used either as the penicillin sulfanilamide mixture or as the solution injected beneath the scalp through tubes. If the patient is febrile sulfadiazine or penicillin should be used systemically.

Not uncommonly an epidural or subdural abscess will be found associated with osteomyelitis. These conditions should be treated by open drainage combined with local and systemic chemotherapy preferably with penicillin.

Meningitis—The onset of fever headache stiffness of the neck vomiting and delirium following head injury is suggestive of meningitis. The diagnosis is confirmed by the lumbar puncture findings of increased cerebrospinal fluid pressure pleocytosis and culture of the offending organism.

Since these post traumatic meningitides are frequently secondary to foci of infection established by the injury efforts should be directed to the eradication of these foci by thorough drainage. Penicillin or sulfonamide therapy should be promptly instituted. Penicillin is administered both intrathecally and intramuscularly. For staphylococcal meningitis the recommended intrathecal dosage is 10 000 Oxford units once to twice daily. Streptococcal and pneumococcal meningitis are treated with 20 000 Oxford units intrathecally once daily. Concurrently penicillin should be administered intramuscularly in a dosage of 20 000 Oxford units every three hours. This dosage is reduced as the clinical condition improves. If penicillin is unavailable the sulfadiazine blood level is maintained at 8 to 12 mg per 100 cc.

Intracerebral Abscess—In the majority of instances intracerebral abscess is a late complication of open head injury generally manifesting itself three to six months following the original trauma. The development of an abscess is suspected from the appearance of headache drowsiness and confusion. Signs of meningeal irritation are variable. Localizing signs are of considerable value but may be absent. Papilledema is present in the greater number of cases.

The site of the brain abscess is determined by the clinical symptoms and signs with the aid of the special diagnostic procedures of electroencephalography and ventriculography. In a patient with an open infected craniocerebral wound particularly with foreign bodies embedded in the brain the abscess will form along the tract of the wound.

When the diagnosis has been established drainage of the abscess

is promptly instituted. Many methods for evacuating the purulent contents have been suggested. These include repeated aspiration of the cavity, drainage through a catheter or a large soft rubber tube, marsupialization and complete extirpation. Each method has its individual merits. We prefer drainage with a large rubber catheter through which the abscess contents can be aspirated and replaced by 3 to 6 cc of penicillin (1000 Oxford units per cc) every three hours. The local treatment is supplemented by intramuscular penicillin in doses of 20,000 Oxford units every three hours. The duration of the treatment is determined by the clinical response.

DESTRUCTION OF TISSUE

Scalp Defects—Every effort should be made to obtain primary closure of scalp wounds. This is essential if there is associated skull and brain damage. It occasionally happens that such closure is impossible without great tension on the skin edges. Under these conditions skin should be mobilized by the use of counter incisions, under cutting or the shifting of a scalp flap (Fig. 509). Flaps should include the galea but not the periosteum. If the surgical counter incisions cannot be closed, they are treated with continuous moist saline compresses until healthy granulation tissue appears. This area is then covered with a thick split graft.

Skull Defects—The indications for the repair of skull defects are either cosmetic or the complaints of postural headache and dizziness (syndrome of the trephined). Many methods of cranioplasty are available. These include the use of grafts of autogenous bone and rib cartilage or alloplastic materials such as vitallium, lucite or tantalum. Because of its inertness in tissue and malleability, tantalum has found wide favor among neurosurgeons. A one stage or two stage procedure may be used. In the former technique the metal is shaped preoperatively or at the operating table and applied to the skull. The two stage method entails a primary exploration in which an accurate impression of the defect is obtained. From this impression an accurately fitting tantalum plate is fabricated and applied at the second stage.

In our series of cases the one stage technique has been used exclusively (Fig. 510). Exposure of the defect is best accomplished by reflecting a scalp flap. Separation of the scalp from the unprotected dura is simplified by distention of the fibrous tissue in the plane of dissection with physiological saline. Any excess fibrous tissue overlying the dura or adjacent skull is resected.

When the defect has been satisfactorily exposed a sheet of 0.015 inch tantalum plate is cut with tin shears to overlap the skull 6 to 8 mm throughout its entire circumference. The desired convexity of the plate is obtained by pounding it in a hollow metal or wooden mold. Holes are drilled in the edge of the plate and the corresponding skull margin for the attachment with vitallium screws. The metal

plate should have multiple perforations centrally to enable fibrous tissue to grow through to bind the scalp and dura. These holes also

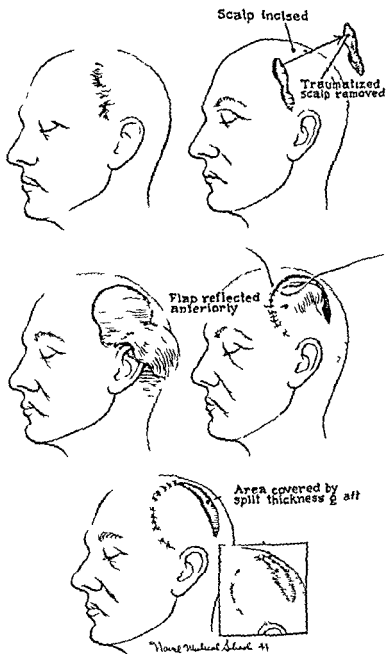


Fig. 509—Plastic closure of scalp. Provides improved cosmetic result after extensive resection of traumatized areas.

prevent the accumulation of fluid beneath the plate. A single Penrose drain is placed between scalp and tantalum plate. Disregard of this

step may lead to a fluid collection which will interfere with the adherence of the scalp to the metal

A pressure bandage is applied at the first dressing. This pressure is continued with an elastic bandage which is worn until the wound is solidly healed

Cerebrospinal Fluid Rhinorrhea and Otorrhea—Leakage of cerebrospinal fluid from the nose and ears is a common complication of head

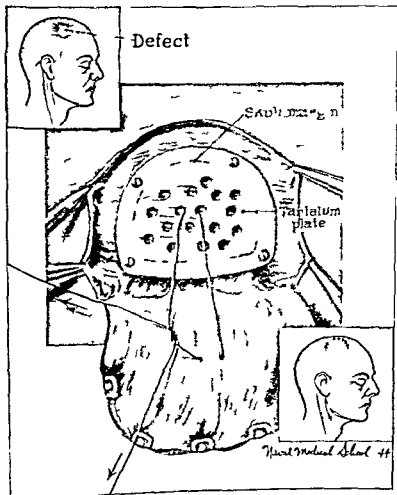


Fig 510—Tantalum cranioplasty. Attachment with tantalum screws. Multiple perforations allow firm fixation of scalp.

injury. Fracture lines extending into the ethmoid plates or petrous pyramids are usually demonstrable in stereoscopic axial roentgenograms of the base of the skull.

Our attitude is one of conservatism in the treatment of these patients. In the cases of otorrhea the pinna is cleaned and covered with a sterile pad. If rhinorrhea exists the patient if conscious is cautioned not to cough, strain, sneeze, or blow his nose. Sulfadiazine is administered as soon as possible and continued until the fistula has closed.

Surgical closure of the fistula is considered only if cerebrospinal fluid continues to drain for more than two to three months or if spontaneous pneumoencephaly has occurred. We have found it necessary to resort to surgical closure of the fistula in only one instance.

Paralytic Phenomena—Included in this group are patients with impairment of the special senses speech motor power and sensation resulting from brain damage. The treatment of this group involves considerable reassurance of the individual patient coupled with an extensive program of reconditioning. Physical and occupational therapy speech therapy and other special measures are employed. Individuals with minor disabilities are returned to limited duty. Patients with more extensive neurological defects are eventually discharged from active military service.

POST TRAUMATIC EPILEPSY

Convulsive seizures of varying patterns are common sequelae of open head injury with wounding of the cerebral cortex. Post traumatic epilepsy may be expected to occur in 20 to 35 per cent of cases with dural penetration. Since the majority of these patients are unfit for military service they are treated with anticonvulsant drugs such as phenobarbital and dilantin. We have not resorted to resection of the epileptogenic cerebral cicatrices in any of our patients.

SUMMARY

Increasing knowledge of the physiological and pathological factors involved in craniocerebral trauma combined with new methods of diagnosis and treatment are steadily lowering the morbidity and mortality rates.

The most important contributions lie in the field of chemotherapy. Since the advent of the sulfonamides and particularly penicillin the dreaded complications due to infection are infrequent and more easily controlled.

Blood derivatives are coming into greater use in neurosurgery. Shock is treated with plasma and serum albumin. Fibrin foam soaked in thrombin is used to control hemorrhage from the brain and dural lacerations. Fibrin films are employed to repair dural defects and prevent meningocerebral adhesions. Serum albumin is an effective agent in combating intracranial hypertension.

Physiologically inert materials are available for the repair of skull defects. Both tantalum and vitallium are in extensive use for this purpose.

In closing tribute is paid to the individuals responsible for the extensive program of reconditioning which will return the head injury patient to civilian life better prepared to cope with the future.

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LOGICAL METHODS FOR ANESTHESIA

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THERE is no specific detailed method of anesthesia that must be used for a certain type of operation in order for good results to be achieved. No more so than that there is a specific technic that all surgeons must use in order to correct a specific surgical disorder. A method of anesthesia administered by an anesthetist trained and experienced in the use of that method may be safe and satisfactory for a certain operation. The same method used for the same operation but administered by an anesthetist not familiar with the method might be dangerous. The ability of the anesthetist is much more important than the method of administration. On the other hand just because an inadequately trained anesthetist is able to get by with the use of one or two methods for all cases does not mean that all his anesthetics were administered by the most adaptable methods. The ability to get by is no longer accepted as a satisfactory standard for anesthesia. In the order of importance safety of the patient and to the surgeon and the comfort for the patient are the objectives of the conscientious anesthetist. All these objectives may be more fully attained by the selection of the method of anesthesia most suited to the type of operation, the ability and technics of the surgeon and the condition and temperament of the patient.

Within relatively recent years the methods of producing anesthesia and the drugs and technics for use in these methods have rapidly increased in number. The justification for anesthesia as a specialty for physicians has thereby come about. The modern procedure is for the surgeon to explain his surgical problem to the anesthetist and the anesthetist after considering the problem and the patient selects the method and agent of anesthesia most likely to result in attainment of the three above mentioned objectives. The surgeon is interested in a safe comfortable patient before, during and after the operation. The purpose here is to consider some of the factors influencing the anesthetist's choice of a method or combination of methods for administration of the anesthetic. The selection of the anesthetic agent is discussed only in its influence on the choice of the method of administration.

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The opinions or assertions contained herein are the private ones of the writer and are not to be construed as official or reflecting the views of the Navy Department or the naval service at large.

ABDOMINAL SURGERY

Probably the greatest problem in abdominal surgery is adequate exposure of the operative site. Even with extreme relaxation of the muscles of the abdominal wall the attachments of the internal organs make their manipulation through the incision difficult. This one factor makes the use of some potent muscle relaxing method almost imperative and excludes for the average surgeon the use of less potent but perhaps more pleasant agents and methods. There can be but little argument that *spinal anesthesia* produces the best relaxation of muscles. Under spinal anesthesia the level of skin anesthesia must be much higher than the upper end of the incision in order to produce satisfactory anesthesia for abdominal operations. To produce the amount of muscular relaxation which is considered satisfactory by the surgeon the level of anesthesia must extend above the ensiform cartilage. Even for operations in the lower abdomen the level of spinal anesthesia must extend to between the sixth and the fourth rib for the patient to be fairly comfortable during a pull on the mesentery of the intestine. This pull usually is felt by the patient as a constriction in the chest or an uneasiness in the upper abdomen and it is frequently accompanied by nausea. The production of a high spinal anesthesia is more frequently associated with a fall in blood pressure than is the case with a low spinal. For this reason the anesthetist must constantly check the blood pressure and be ready to administer a quick acting vasoconstrictor drug such as ephedrine sulfate intravenously or neosynephrine hydrochloride intramuscularly. The average patient can rarely be comfortable during manipulations in the upper abdomen under spinal anesthesia alone. For this reason spinal anesthesia for upper abdominal operations is best supplemented with an analgesic dose of sodium pentothal or cyclopropane.

General anesthesia is the method most commonly selected for all surgical procedures usually because the patient prefers not to undergo the psychic strain of being operated on while conscious. Even the most stable and well premedicated patients will become hot, uncomfortable and restless at the end of an hour of being operated upon under a local agent. If the operating time is expected to be longer than an hour and a half a general anesthetic should be administered from the start or else provision should be made to supplement the local with general anesthesia at the end of an hour. This is especially applicable to women.

When general anesthesia is selected as the one method to be employed for an abdominal operation an agent of adequate potency such as ether or cyclopropane must be chosen in order to provide the satisfactory degree of muscular relaxation. The safety of the patient is being jeopardized by the use of a whiff of gas and its inevitable production of anoxia.

For the average surgeon who is not willing to operate on an abdo

men in which the muscles are tense *intravenous anesthesia* alone is seldom the best single method to choose. Intravenous anesthesia can be combined with local anesthesia to produce a most satisfactory combination for abdominal surgery. This combination is a safe and comfortable method of anesthesia for the poor risk patient especially when an extensive procedure is not planned.

The following are suggested methods of anesthesia for the average case for abdominal surgery.

Lower Abdomen Spinal anesthesia

Upper Abdomen (1) General anesthesia with a potent agent

(2) Spinal anesthesia supplemented with an analgesic dose of a not too unpleasant agent

ORTHOPEDIC SURGERY

Surgery on the extremities has been found both in civilian and military practice to be very satisfactorily done under *intravenous anesthesia*. For procedures lasting several hours the total dosage of intravenous anesthetic agent can be materially reduced by starting the operation under spinal or local and changing to intravenous anesthesia when the local agent has worn off. The total dose of pentothal may also be materially reduced by administering 50 per cent nitrous oxide and 50 per cent oxygen by inhalation at the same time that the pentothal is being given. A *low spinal anesthesia* is relatively safe and affords the maximum muscular relaxation for operative procedures on the pelvis and lower extremities. Patients with severe injuries of the lower extremities on which traction is being maintained may be slowly raised to a semi sitting position by a pull on the arms by an assistant standing at the foot of the bed. This gives enough room for the anesthetist to administer a spinal anesthetic and makes possible a painless transfer of the patient from the fracture bed to the operating table.

Orthopedic procedures on the vertebrae usually necessitate having the patient face down on the operating table. This is a most unfavorable position for adequate respiration since the muscles of respiration have to raise almost the entire weight of the body during each inspiration.

With the head turned sharply to the side an adequate airway is difficult to maintain in this position. For these two reasons it is always best to have an intratracheal airway in place before turning the patient under general anesthesia into the prone position. Since the agents used for intravenous anesthesia are powerful respiratory depressants it is safer not to add such an additional embarrassment of position to an already depressed respiratory system.

Operations which involve a lot of hammering and chiselling on bone are quite shocking to the patient under either local or general anesthesia. The fall in blood pressure which may be rather sudden

apparently is on a neurogenic basis and the response to a vaso constrictor drug is usually satisfactory

The following are suggested methods of anesthesia for the average case for orthopedic surgery

- | | |
|--------------------|---|
| <i>Extremities</i> | (1) Short operations—intravenous anesthesia |
| | (2) Long operations—local or spinal anesthesia followed by intravenous anesthesia |
| <i>Vertebrae</i> | (1) Intratracheal general anesthesia |
| | (2) Spinal anesthesia |

NEUROSURGERY

Surgery on or about the brain involves danger to the most vital parts of the body. The anesthetist is not concerned so much in maintaining a state of anesthesia as he is in being prepared beforehand to meet the frequent emergencies that endanger life during craniotomies. Many brain operations are most advantageously done with the patient in the upright or semi upright position. Anesthesia which causes a generalized vasodilatation makes this a dangerous position due to *the pooling of blood in the most dependent parts* with resulting shock and anoxia of the higher centers. Bandaging the feet, legs and thighs before putting the anesthetized patient in the upright position helps to partially counteract this tendency of the blood to pool in these dependent members of the body. A device such as that recently devised by Craig * which allows the patient to be in the sitting position but still keeps the feet level with the patient's heart is a further step in the prevention of the sudden circulatory collapse which is so frequently encountered during brain surgery. Before any procedure is begun during which a circulatory collapse is likely to occur a large bore needle preferably a 15 or 13 gauge should be inserted in a superficial vein. The lumen of the needle may be kept patent either by the insertion of a stylet or by a slow drip of intravenous fluid such as saline or 5 per cent glucose. When such a needle is in place the anesthetist is able to immediately institute therapy for circulatory failure with blood plasma or any indicated medication without the delay and uncertainty of doing a venipuncture on collapsed veins.

The other most dangerous complication that may occur during brain surgery is a *cessation of respiration*. The position of the patient and the drapes for the sterile field usually make the jaw and tongue almost inaccessible to the anesthetist. In the event that the patient's airway becomes inadequate or artificial respiration becomes necessary the anesthetist has to work at a disadvantage and with much inconvenience to the surgeon. For this reason all patients undergoing a craniotomy under general anesthesia should have an intratracheal airway put in place before the operation is begun. The use of such an intratracheal airway will make necessary the selection of some an-

thetic agent more potent in abolishing the pharyngeal and laryngeal reflexes than the agents usually administered by the intravenous or rectal route. The advantages of having a patent and adequate airway at all times greatly outweigh any supposed advantages of intravenous or rectal methods of producing anesthesia certainly as far as the safety of the patient is concerned.

Intravenous anesthesia is the method of choice for encephalography. *Facial anesthesia* may be used for encephalograms but the patient is usually very uncomfortable. *Local anesthesia* is the safest method for the extremely poor risk patient especially if he is in a coma or semi-coma. If the surgical procedure relieves the coma and the patient begins to react while still on the operating table as not infrequently occurs upon the removal of a subdural hematoma the local may be supplemented by light intravenous anesthesia.

Many neurosurgeons prefer to use electrocoagulation for hemostasis which adds to the *danger of anesthetic explosions*. Ether and air is definitely less explosive than ether and oxygen or an inflammable gas such as ethylene or cyclopropane and oxygen. The anesthesia may then be inducted with gas oxygen and ether or with an intravenous agent and ether until the intratracheal tube is in place. The anesthesia can then be maintained with open drop ether or ether in the Flagg can. When the open ether is separated from the operative field by heavy drapes and the coagulation machine is placed 10 feet or so away the danger of fire is small and the danger of an explosion almost negligible. The anesthesia machine with attached oxygen tanks should always be kept just outside the operating room in case it should be needed to administer oxygen through the intratracheal tube by manual pressure on the bag for artificial respiration.

Surgery of the peripheral nerves requires only a light stage of anesthesia and as in orthopedic surgery of the extremities is well adapted to intravenous anesthesia. *Surgery of the deeper nerves* such as splanchnic and sympathetic nerves is similar to kidney surgery. Deep heavy muscles must be relaxed for exposure by some potent anesthetic agent. The blood pressure during section of the sympathetic nerves especially if done for hypertension is apt to be quite labile and this makes spinal anesthesia more of a risk than general anesthesia. Since the pleura may infrequently be opened during either thoracic or lumbar sympathectomy the precaution of having an intratracheal tube in place for the administration of positive pressure anesthesia is justified. When the hole in the pleura is ready to be closed the tip of an ordinary urethral rubber catheter may be inserted into the pleural cavity and the wound of the chest wall closed tightly about the catheter. Before the skin is sutured the anesthetist can expand the collapsed lung by positive pressure and the air in the pleural space can escape through the catheter. The skin
The skin

is closed as usual further sealing off the pleura. The inconvenience and danger of a pneumothorax is thereby avoided during the convalescence.

The following are suggested methods of anesthesia for the average case for neurological surgery

<i>Brain</i>	Light intratracheal general anesthesia
<i>Peripheral Nerves</i>	Intravenous and/or local anesthesia
<i>Deep Nerves</i>	Intratracheal general anesthesia

THORACIC SURGERY

The production of anesthesia for operations on the chest wall and thoracic contents is perhaps the most technically difficult of all the duties of the anesthetist. The avenue for the introduction of the inhalation anesthetic agents is also the part that is disabled by the pathologic condition and by the operation. The patient is forced to lie on the best functioning lung so that the diseased lung or side may be attacked by the operator. Positive pressure must be maintained in the trachea through a tube so that paradoxical respiration may be prevented. An adequate expansion of the lungs must be maintained while the pleura is open to bring the oxygen in the anesthetic mixture in contact with a large enough area of alveoli lining to permit absorption of the oxygen into the blood.

Only a light stage of anesthesia is necessary and it is advantageous to have the patient able to expel the bronchial secretions as soon after the completion of the operation as possible. *Intravenous anesthesia*, especially when combined with local is suitable for chest surgery but by this method a central respiratory depressing drug is combined with a disabled peripheral mechanism. The recovery from intravenous anesthetic agents is also apt to be prolonged following a long operation which requires a large dose of the drug.

Spinal anesthesia has also been advocated for use in chest surgery. This method paralyzes part of the muscles of respiration in patients who are already having difficulty in breathing. The blood pressure is also more difficult to maintain at adequate levels during hemorrhage under spinal anesthesia because of the dilatation of the blood vessels in the widely anesthetized area.

Massive sudden hemorrhages which are not readily controlled may occur during intrathoracic operations. The anesthetist should therefore have one or more 15 gauge needles already in a vein or veins and have an ample supply of blood and plasma with which to maintain the circulating blood volume.

If bronchoscopy is not available the air passages may be kept free of pulmonary secretions both during and after the operation by the introduction of a flexible rubber suction catheter through the intratracheal tube. Otherwise the secretion will tend to gravitate to the lower good lung and occlude the air passages. A size 14 French catheter

ter is about right for use through a No. 6 or No. 7 Magill intra-tracheal tube. A whistle tipped catheter is much more effective than the regular urethral catheter.

The following are suggested methods of anesthesia for the average case for thoracic surgery:

<i>Pleura To Be Opened</i>	Light intratracheal general anesthesia
<i>Pleura Not To Be Opened</i>	Local and/or intravenous anesthesia

GENITO URINARY SURGERY

Most *diagnostic procedures* on the genito urinary tract are of short duration and do not require a deep degree of anesthesia. For these reasons they can be performed under intravenous anesthesia with satisfaction to both the patient and surgeon. *Operations on the lower end of the tract* such as transurethral prostatectomy can also be done very well with intravenous anesthesia. As a rule the prostatectomy patients are especially poor risk patients frequently with cardiovascular complications. Some type of local anesthesia is preferred by many anesthetists and surgeons as being the safest for this group of patients. A spinal anesthetic produced with 10 to 90 mg. of procaine dissolved in 2 cc. of spinal fluid and injected in the interspace between the fourth and fifth lumbar vertebrae will give analgesia of the prostatic area for forty to forty five minutes without much fall in blood pressure. A combined sacral and caudal nerve block will also give excellent anesthesia of this area without serious cardiovascular changes for a period of one to two hours. By this latter method the dome of the bladder will usually remain sensitive enough to allow the patient to tell the surgeon when the bladder is becoming overdistended.

Operations on the upper urinary tract are more formidable procedures and usually require more muscle relaxing anesthesia. Spinal anesthesia produces a satisfactory field for the surgeon but unless the level of sensory anesthesia extends up to between the sixth and the fourth thoracic nerves the average patient will feel quite a bit of dull discomfort from a pull on the kidney. The combination of the kidney position and a high spinal anesthetic makes a sudden fall in blood pressure not uncommon. This decline in blood pressure is usually easily controlled by the administration of up to 5 mg. of ephedrine sulfate intravenously.

The following are suggested methods of anesthesia for the average case for genito urinary surgery:

<i>Lower Tract</i>	Intravenous or local anesthesia
<i>Upper Tract</i>	Spinal or general anesthesia

PROCTOLOGIC SURGERY

The type and extent of anesthesia necessary for operations on the anus and rectum is very similar to that for the lower urinary tract.

Caudal nerve blocks are gaining in popularity as a larger number of anesthetists trained in the use of this somewhat technically difficult procedure become available. The advantages of this local block over a low spinal anesthetic are that the immediate changes in blood pressure and the possibility of a post spinal headache are avoided.

Intravenous anesthesia in a safe depth does not produce the desired anal muscle relaxation. Inhalation anesthesia must be produced with strong concentrations of potent agents to secure the operative conditions in this area comparable to those produced by the local agents. Such deep stages of general anesthesia are frequently followed by an unpleasant recovery. Infiltration of the operative site is hazardous due to the inevitable bacterial contamination of this area.

The following are suggested methods of anesthesia for the average case for proctologic surgery.

- (1) Caudal sacral nerve block.
- (2) Low spinal anesthesia.

SURGERY ABOUT THE FACE

Without a doubt the safest form of anesthesia for this area is *local infiltration of the operative site* or a nerve block if practical. Then the patient can maintain his own airway. The use of local anesthesia however requires the cooperation of an emotionally stable patient a factor which cannot be controlled in all cases. The procedures are frequently long in duration perfect anesthesia cannot always be secured and the patient's mouth and nose must frequently be kept covered with drapes thus even the best subjects for local anesthesia become hot, restless and very uncomfortable.

Under any type of general anesthesia the great worry and responsibility of the anesthetist is to be able to maintain an *adequately patent airway*. The operative field which must be kept sterile is also the field in which the anesthetist has to work. In all areas except the nose and mouth the anesthetist and surgeon may reach a compromise about the area that each is to have in which to do his work. Usually both are handicapped as a result but the use of the intravenous, rectal or ordinary inhalation methods of anesthesia is possible. The insertion of a pharyngeal airway under light intravenous anesthesia frequently causes a laryngospasm which upsets the whole surgical team.

It is therefore necessary during operations under general anesthesia on the nose and mouth and preferable for all long operations about the head for an intratracheal tube to be inserted. The patient's airway is then secure, the anesthetist and anesthesia machine can be pushed out of the way, the whole head draped, all the assistants can step up close and the head may be moved in any advantageous position without any danger (Fig. 511). For operations in or about the mouth the intratracheal tube should be put through the nose for operations in or about the nose the tube should be put through the

mouth. In both cases a tube with a cuff should be used or the pharynx packed with wet gauze to prevent blood, pus and mucus from entering the trachea around the tube. A roll of ordinary gauze bandage 3 inches wide may be wet thoroughly, wrung well and packed about the tube in the hypopharynx with one hand while the lower jaw and tongue are depressed by the fingers of the other hand. The free end of the gauze should be left hanging outside the mouth so that the packing may easily be removed at the end of the operation and so that the anesthetist will be reminded that the pack is still in place. Otherwise the intratracheal tube may be removed while the pack is

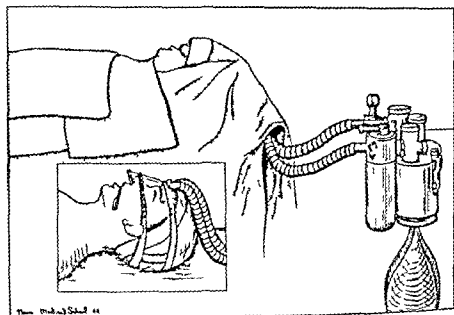


Fig. 511—Anesthesia arrangement for operations about the head and neck

still in and the patient's airway be completely occluded without the cause being immediately evident.

The following are suggested methods of anesthesia for surgery about the face and neck:

- (1) Local anesthesia
- (2) Light intratracheal general anesthesia

INTRATRACHEAL INTUBATION

In this discussion the use of general anesthesia administered through an intratracheal tube has been frequently advised. Perhaps some readers will think that its use is not justified in many of the types of cases for which it has been suggested. The popularity of the use of the intratracheal tube is in direct proportion to the ability of the anesthetist to insert such tubes. If an anesthetist can insert a tube

into the trachea with as much ease as and with less trauma than in inserting a pharyngeal airway he naturally is going to advocate the use of intratracheal anesthesia. On the other hand if the insertion of an intratracheal airway is a struggle for the anesthetist the patient's teeth get broken and his throat lacerated and the patient frequently has to be reanesthetized several times during the procedure then the use of intratracheal anesthesia by that particular anesthetist is unwarranted. In the beginning it was pointed out that the ability of the anesthetist was one of the most important factors to be considered in the selection of the method of anesthesia.

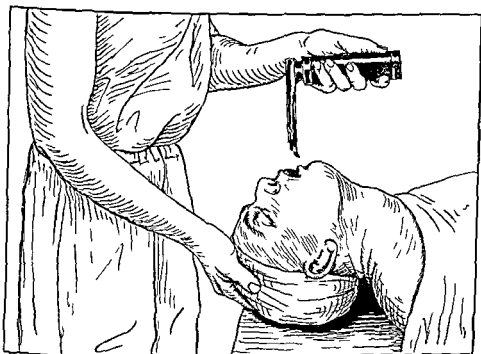


Fig 512—First step in the insertion of an intratracheal airway through the mouth

There are three simple maneuvers which greatly facilitate the introduction of an intratracheal tube through the mouth without injury to the patient. In fact these steps are so simple that few students of intubation will give them enough thought to include them in their technique.

First Step Hyperextend the patient's head by downward pressure on the vertex with the right hand of a right handed operator (Fig 512). This causes the patient's mouth to stay open so that the laryngoscope blade will almost fall into the pharynx as far as the tip of the epiglottis.

Second Step The patient's head is kept in a position of hyperextension by pressure with the anesthetist's abdomen. The right thumb is

placed on the patient's right lower molars and the right fingers curved around the right horizontal ramus of the patient's mandible (Fig 513). By elevation of the mandible the tip of the epiglottis is raised and the blade of the laryngoscope can be passed between the epiglottis and the posterior pharyngeal wall without curling the tip of the epiglottis back on itself.

Third Step The patient's head is kept hyperextended by pressure on the vertex with the ulnar side of the anesthetist's left forearm. The left wrist of the anesthetist is kept hyperulnar flexed in order that the handle of the laryngoscope may be kept in a forward tilted



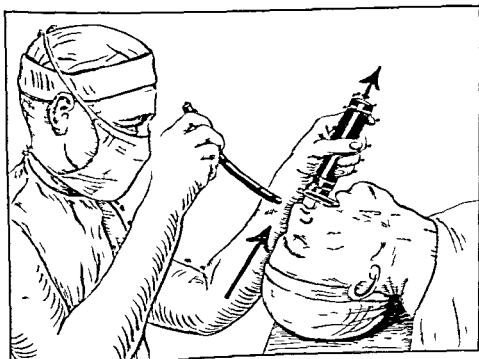
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Fig 513—Second step in the insertion of an intratracheal airway through the mouth

position (Fig 514). The tongue and epiglottis are elevated to expose the larynx of the patient by an upward lifting motion executed by the shoulder of the anesthetist. The handle of the laryngoscope is kept at an acute angle in relation to the anterior chest wall; there is no motion of the wrist and the pressure on the patient's forehead is maintained or increased by the forearm. The whole purpose of this last maneuver is to prevent injury to the patient's upper incisors by the blade of the laryngoscope. Many anesthetists use the patient's upper incisors as a fulcrum and try to elevate the patient's tongue and epiglottis by using the blade of the laryngoscope as a lever. This method causes a great pressure to be exerted on the upper teeth and

frequently results in damage to the teeth or to artificial dentures. By the method described the blade of the laryngoscope is actually pulled away from the upper teeth rather than toward them.

Another mistake that is frequently made is the attempt to intubate while the patient is still in too light a plane of anesthesia. The pressure of the laryngoscope blade then causes a laryngospasm and it is impossible to insert the tube through the larynx. The patient in whom anesthesia has just been induced will rapidly become less anesthetized even though no respiration is allowed; therefore no time must be lost by fumbling while putting the tube into the trachea.



Harvard Medical School

F 514—Third step in the insertion of an intratracheal airway through the mouth

The passage of a tube blindly through the patient's nose into the trachea involves a lot of luck and a sense of feeling and hearing which is not easily described. If the nasal tube cannot be passed blindly, the larynx may be exposed as described, the tip of the nasal tube grasped with forceps as it lies in the hypopharynx and the tip guided into the larynx. The tube can then be inserted to the desired depth by pressure on the portion still extending from the nose.

SUMMARY

Methods of anesthesia have been suggested for various types of surgery. Some of the reasons for considering these to be logical methods of anesthesia for the surgical problems have been discussed.

CHOICE OF PEDICLE FLAPS FOR PLASTIC AND RECONSTRUCTION SURGERY

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SKIN and fat must be used in many instances to effect repair of war wounds with loss of substance Davis⁴ writing during the last war stated that in the present war (1914-1918) there have been many whose wounds have caused the loss of skin and subcutaneous tissue and even deeper tissues in situations which ultimately will require a resistant elastic healing before a satisfactory functional result can be obtained Many of these defects can be properly remedied only by the use of pedunculated flaps of skin and subcutaneous tissue

Since the last war plastic and reconstruction surgery has so greatly broadened in usefulness that pedicle flaps are now employed freely for a variety of defects previously uncorrected Not only are losses of substance repaired by this means but by the removal of scar and replacement with normal skin and fat many procedures in orthopedic surgery neurosurgery and other important specialties are now made possible

Skin and fat will not survive when transplanted without constant blood supply The many types of pedunculated flaps constitute a bewildering answer to the surgeon who seeks information on this type of grafting procedure It seems advisable therefore to present in detail various factors determining the choice of flaps for plastic and reconstruction surgery All phases of surgical judgment contribute to this choice but certain general rules have been developed through experience which should be reiterated as the need for extensive plastic and reconstruction surgery develops in this war Writers since the beginning of surgery have recorded their experiences in this field and elaborate discussions of design and method are available in the works of Sir Harold Gillies John Staige Davis and others who have followed them in the development and use of pedicle flaps Definitions of every possible type of flap would far outstretch the limits of this paper but well established rules as to design and technic seem noteworthy and are presented as a guide

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GENERAL CONSIDERATIONS

Blood Supply—The basic principle of all pedicle flaps is preservation of the original blood supply while the flap is growing to its new source of supply. The elementary ideas are illustrated diagrammatically in Figure 515. In *A* the vessels are seen to supply a hypothetical area of skin and fat from all directions. This can be considered the normal state of affairs in any donor site before a pedicle is outlined. In *B* two lateral incisions have been made producing reinforcement of

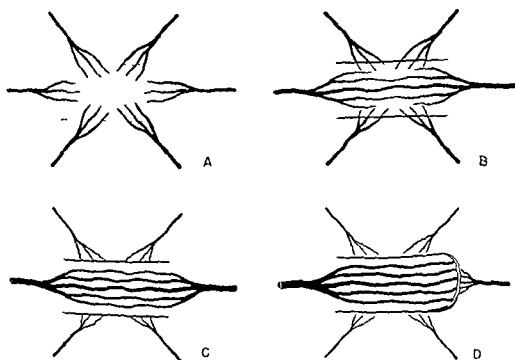


Fig 515—Circulation of a pedicle flap *A* Diagrammatic vessels supply a hypothetical flap donor area from all directions. Dotted line indicates proposed pedicle flap. *B* Lateral incisions have been made. Circulation has been "reinforced" from the ends of the flap and atrophy of lateral vessels has occurred. *C* Longitudinal vessels considerably enlarged. Outline of proposed division of end of flap is indicated by the dotted line. *D* End of flap divided and raised. All circulation is now present through the base of the flap.

the circulation from both ends of the flap and shutting off the lateral vessels. In *C* reinforcement has been augmented and prospective division of one end of the pedicle will not seriously impair the blood supply. In *D* this terminal division has been made and a simple pedunculated flap has been produced, nourished entirely through its base.

Pedicles in general tend to develop a more facile circulation as successive stages in delay and transfer are carried out. It is surprising how quickly a flap will obtain adequate nourishment from a new source once previous transfers of its pedicle have been

Figure 515 *D* the relatively increased vascularity is well illustrated in contrast to the tissues surrounding the donor site

Rotation of Flaps—Flaps can be raised directly from their bed and rotated through angles up to 90 degrees as a primary operation provided that they are fairly short, of sufficient thickness and have an adequately broad base for nourishment. Doubling a flap on itself for more than a 90 degree angle is seldom advisable without a delay for reinforcement of its circulation.

Importance of Delay—By delay is meant a raising of the flap in stages often returning it to its bed to wait further circulatory reinforcement. Any increase in length of a pedicle narrowing its base or alteration in the proportions between these two dimensions may necessitate a delay. Decision regarding delay or transfer of a pedicle may be made in most instances in advance of the actual operation through a knowledge of the size proportions and utilization of the flap but the cautious surgeon must be prepared at the operating table to return a pale or dusky flap to its bed and postpone the proposed transfer. One has only to count the time lost to a patient and the surgeon by failure of circulation of a flap to realize that caution in this regard is well exercised.

PRACTICAL PHYSIOLOGY AND PATHOLOGY

Several factors tend to operate against the development or maintenance of adequate circulation in a pedicle. Among these are mechanical factors such as *tension* or *torion*. The former produces faulty healing between the pedicle and recipient site and decreases the caliber of vessels supplying or draining the flap. *Torsion* similarly decreases caliber of capillaries, arterioles and venules and will produce serious impairment of circulation. *Infection* however slight interferes with proper healing of the flap and is to be avoided wherever possible although the resistance of a well nourished flap to infection is very great. *Lymphedema* results at times from even the mildest degrees of infection. When an infection is more serious all the defense processes of inflammation are mobilized in the presence frequently of decreased venous and lymphatic return and endothelial damage. Thrombosis follows and tissue death results. The arterial circulation of a well planned flap is usually quite adequate if the base is broad and sufficient thickness of fat and subcutaneous tissue is present to preserve the natural vascular bed. The venous and lymphatic return however are easily embarrassed. Provision for this return circulation is the main essential in calculating the position of the base or direction of the long axis of a pedicle flap. This has been stressed by Dr. Jerome P. Webster¹³ in his discussion of thoraco epigastric tubed pedicles in which he states that the danger of impairment of vascularity by mechanical occlusion in closing the

thoraco epigastric tube is less great in this region because of the presence of the large venous drainage system already existing before operation

In the absence of adequate return circulation *congestive hyperemia* occurs. The cycle followed is that of edema, chronic passive congestion and finally 'wet gangrene' of the flap. Proper return flow is usually present in a flap with its base in the proximal position on an extremity or away from the midline if on the abdomen or chest. Pedicles about the head and neck have such rich circulation that less attention need be paid to vascular direction.

If one follows the embryonic segmental distribution of the vessels good circulation is most apt to be present. A flap so designed in the physiological direction normally includes adequate venous and lymphatic return. Vertical pedicles on the trunk or transverse ones on an extremity or pedicles which cross the midline of the trunk are essentially unphysiologic as regards their natural vascular components and an allowance must be made for this condition. If the base of the flap is large enough in proportion to its length no harm may result from this altered direction but in general it is better to create a flap in accordance with the segmental distribution of the vessels. Study of the subcutaneous vascular distribution in an atlas of anatomy is helpful in planning physiologic flaps.

Normal folds and flexion creases of the skin (Langer's lines) should not be crossed at right angles by the margins of a flap. Scar contractures occur at the margins of the donor site when this is done. Similarly application of a flap to a recipient site with marginal lines antagonistic to the flexion creases will produce linear contractures about the completed graft.

The *general condition of the patient* blood count, hemoglobin level, vitamin level, serum protein and all factors contributing to good wound healing should be of the highest order for prompt and successful grafting by the pedicle method. Not the least of these is good surgical technic which emphasizes gentleness, sharp dissection, accurate hemostasis, fine ligature material and asepsis.

TYPES OF FLAPS

The confusing and inconsistent classification of pedicle flaps found in the surgical literature can be simplified by considering flaps as belonging to only two main types. These are (1) direct flaps and (2) intermediate flaps.

Direct Flap—By this is meant a flap which is outlined, raised and applied directly to its recipient site *in one operation*. Such flaps are usually of the open rather than the tubed variety (see below) although occasionally margins on the base of an open flap may be approximated to form a partial tube. Direct flaps may be derived

from the vicinity of the defect to be covered in which case they are known as local or sliding flaps (Fig 516) They may be lifted from a more remote region for direct application to an accessible extremity (Fig 517) The affected extremity may be partially or entirely buried beneath the skin and fat of a convenient area producing a glove or strap flap (Fig 518)

The advantages of a direct flap are chiefly the advantages of brevity covering a defect without preliminary steps of preparatory surgical procedure The popularity of the direct flap has so greatly increased since the time of the last war owing to this single factor of expediency that in most clinics it far outweighs the intermediate flap in frequency of application



A



B

Fig 516—Direct flap of sliding type *A* Lateral view of neck Abundant scar has been removed from about the larynx and hyoid bone incidental to the surgical cure of a thyroglossal duct cyst which had been operated three times previously at other hospitals Closure of defect after removal of scar is accomplished by sliding a double-end flap from the prethyroid area *B* Closure of secondary defect by application of a thick-split graft from the thigh

Intermediate Flap—By intermediate flap is meant the transfer of skin and fat by a *multiple stage procedure* in which a flap is prepared in one stage and then in subsequent steps is transferred to its final location by repeated shifting operations (commonly called waltzing) or by the use of an extremity as a carrier for temporary blood supply (Fig 519)

Tubed Flap vs Open Flap—Briefly stated the major advantage of a flap which is attached at both ends and rolled into a tube is that by closing all raw surface an aseptic field is created and the presence of contamination from an open granulating surface is eliminated This makes possible a clean surgical field throughout the many stages of a prolonged reconstruction problem



A



B

Fig 517—Direct flaps for repair of large defects of foot (such defects are larger than could be corrected easily by a tubed pedicle) A Repair of sole of foot destroyed by gunfire (Right thigh is donor site) B Repair of defect created by excision of dense scar which was adherent to tendons, bone, and joint following a huge infected pressure ulcer from a constriction applied elsewhere. This ulcer had caused extensive deep scarring in complete disability of foot and ankle (Left thigh is donor site)

imum dressing ensures a relief from treatment during the waiting interval (4) Movability owing to the ease and frequency with which the flap is attached to the wrist for a temporary blood supply it can be transported from the abdomen quite easily to any part of the body where the hand can approach

In many instances these premises are true and for transfer of flaps to areas impossible of coverage by direct flaps the tubed pedicle is



Fig 519—Intermediate flaps—tubed and open A Tubed flap raised on the flank and attached to the wrist for transfer to a long adherent scar over right arm Note healed thick split graft on donor bed and covering of pedicle attachment on abdomen by a smaller thick split graft which has been sutured in place at this operation B Similar tubed flap is used to cover a scar of an old shrapnel injury to the dorsum of the left foot C An open flap has been sutured to the left wrist from the flank The undersurface of the flap is left open to form a temporary covering of scar epithelium This flap was designed for covering an amputation stump and the flap when completed and moved to the leg extended around the flank beyond the limits of this photograph

is often the best method The tube is of exceptional value in facial reconstruction and reference to Gillies' writings gives ample testimony to the usefulness of this method In considering his listed points of superiority of tubed grafts however one feels a certain air of skepticism based on practical experience with not infrequently delayed healing of tubes unfortunate losses due to severe kinks or twists inconvenience of position even with tubes prolonged sometimes for several weeks and no decided advantage in movability

A further criticism of the tube is that it is long and narrow even when opened to its widest extent and as such is unsuitable for many wider defects. Its theoretical advantage of asepsis is only relatively important for a direct flap if properly handled in the majority of instances gives as good an end result as does the tube. Furthermore the corners of the scar beneath the tube where its donor site is joined is very commonly delayed in healing. To obviate this in this clinic the donor bed beneath the tube has been grafted rather than approximated (see Fig 519 A). Even this is not entirely satisfactory for the loss of a tiny bit of graft from hematoma will still delay procedure if absolute asepsis is desired.

An open flap can be raised and attached to the wrist or forearm as easily as a tube and its undersurface can be covered temporarily by small bits of Thiersch graft and thus kept quite clean (see Fig 519 C). It is possible to move huge flaps of skin and fat by the open method which would be entirely impossible by the tubed method.

CLINICAL APPLICATIONS

Among the basic generalizations which are necessary for success in all flap operations are two cardinal rules.

1. Make sure the flap is large enough to allow for all shrinkage of the flap itself as well as expansion of the recipient site when tight scar is released.

2. See that the flap will work mechanically. Tricks angles of application may produce a flap which will not reach its final site at the proper angle or an extremity unexpectedly will not bend around a curve to receive a flap which is too short or impossibly placed.

Accidents resulting from failure to observe the cardinal rules above are cruelly disappointing to the patient and a source of deep chagrin to the surgeon.

Fixation—The flap should be relaxed in its position to avoid tension on the suture line. Secure immobilization is necessary to prevent this tension from occurring. For pedicles on the *lower extremity* the use of a plaster cast is almost mandatory. Such a cast may be lightened considerably by incorporating broomsticks to brace the segments which would otherwise be connected by solid plaster strips. The joints and all pressure areas should be carefully padded particularly in positions overlying superficial nerves. Felt and sheet wadding are most convenient for this purpose.

Flaps for the *upper extremity* are more easily splinted and fixed by adhesive tape bindings. A flexed elbow can be comfortably splinted to the side by a pillow and the slight motion allowed at the elbow is not sufficient to disturb most flaps. Arm flaps to the head and face are quite simply secured by adhesive tape fixated about a head band of bandage using reinforcing strips of adhesive somewhat the

same position as illustrated in Tagliacozzi's original drawings of rhinoplasty.

Fixation is not required for local or sliding flaps. If a pedicle flap is sufficiently long as in the case of thoraco epigastric tubed pedicles the end of the tube may be transferred directly leaving all extremities free.

Closure of Donor Area—Closure of the denuded area from which a flap is raised is accomplished either directly by undermining the adjoining margins and approximating them or by utilizing a thick split skin graft from some other area. A common error when deciding on the latter method is to take the graft from the same extremity from which the flap is raised. This is inadvisable because the application of pressure dressings to the donor site of the thick split graft proximal to the pedicle flap may result in constriction with venous and lymphatic stasis in the flap. In such instances removal of the thick split graft from a distant area such as on the trunk is preferred. To allow a large donor bed to remain open is bad practice for the loss of tissue fluids, additional bacterial invasion and contracture detract from the success of the venture. Such donor beds are sterile when the flap is first raised and grafting at this time is much more satisfactory than at a later date.

Division of the Pedicle—Flaps are usually left attached for a period of three weeks to receive their blood supply from the new bed. Variations from this interval may be dictated by circumstances. For example, if a flap is designed to cover an area which is sufficiently small to be covered entirely by the end of a tube or flap, division may be made earlier than when that attachment must nourish a larger portion of flap which is swung down after pedicle division. Flaps about the head and neck tend to receive their blood supply more rapidly than flaps on an extremity. This is also true to a less degree in the case of hands and fingers because of their rich blood supply.

Dressings—Good surgical care is necessary for dressing of all flaps and in most instances normal saline wet dressings which are changed at frequent intervals utilizing fine mesh gauze next to granulating surfaces most rapidly heal obstinate corners and folds beneath flaps. The use of any local antiseptic for these areas is not recommended. Redundant granulations are destroyed as necessary by the application of a silver nitrate stick.

Only by meticulous attention to detail and observance of principles of good surgery as epitomized by Halsted⁸ will excellent results in this branch of plastic and reconstruction surgery be attained.

SUMMARY

1. Wounds with loss of substance frequently require pedunculated flaps of skin and fat. The proper design of such flaps is outlined as

cording to principles of normal tissue physiology and wound healing. In designing such flaps advantage should be taken of the normal venous and lymphatic return of the subcutaneous vascular bed.

Flaps are divided into (1) direct flaps which are raised and applied in one operation and (2) intermediate flaps which are prepared in several stages before transfer. Advantages and disadvantages of the tubed flap and open flap are discussed.

Two rules for clinical application of flaps are of paramount importance. First, design a large enough flap to allow for contracture; second, carefully plan the mechanical details of flap application. Methods of securing flaps, closure of donor sites and other pertinent clinical information is presented.

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PROBLEMS PRESENTED BY FOREIGN BODIES

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THE present war emphasizes again as previous wars have the problem of treating patients who as a result of their service in the armed forces have embedded in the tissues or located in the body cavities one or more foreign bodies. Treatment for the purpose of saving life or anatomical parts restoring function preventing deformity and disabling symptoms following wound healing has varied as medical knowledge increased and weapons changed. The excellent results obtained in the treatment of the wounded in the present war are the result of the use of plasma the sulfonamides penicillin, well organized medical facilities and a competent medical personnel which has permitted early and effective treatment. No form of treatment has, however decreased the need for the application of sound surgical principles and the employment of careful operative procedures.

Foreign bodies present a variety of problems from the time of their entrance into the body until they are removed or become symptomless as the result of becoming encapsulated in scar tissue. The latter process may eliminate them from interference with the functions of the part in which they are embedded as effectively as removal. The problems presented concern the civilian physician as well as the military surgeon as the former will see casualties of this group for many years after the war and will be called upon to decide whether or not the symptoms of which the patient complains are the result of a foreign body or the scarring caused by its passage through the tissues, or are attributed to it without organic basis by a patient who has knowledge of its presence. Removal of the foreign body in this latter group of cases will often be insisted upon by the patients who repeatedly request it or frequently present their cases for surgical consideration constituting a constant invitation to perform unnecessary surgical procedures.

INDICATIONS FOR REMOVAL OF FOREIGN BODIES

Early Treatment—Indications for removal depend on the length of time elapsing between the injury and the time of treatment and must

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necessarily be divided into those of early and late treatment. If seen directly after the wound is received the foreign body or shrapnel may be quickly and frequently easily removed having been previously localized with a probe through the wound of entrance by x-ray or with the aid of a foreign body locator. When first seen the wounds of shrapnel are often gaping and permit access to the base. This chance is lost as soon as granulations start. Such wounds after careful debridement should be left open and adequately drained. Sulfonamides and penicillin should be used either separately as is usually done or they may be used together. Local application of either drug is much inferior to general therapy but may especially in the case of penicillin add to the effectiveness of the treatment if used in addition to general therapy. Foreign bodies other than metals such as pieces of clothing, splinters of wood and bits of soil produce a greater reaction in the tissues and are more likely to cause severe infection and less apt to become encapsulated in the process of wound healing. The presence of foreign bodies in wounds where injury to bone is present increases the risk of osteomyelitis developing increases its severity if it does develop decreases the effectiveness of penicillin and tends to prevent fractures from healing in normal alignment.

Though there are definite indications for early removal such as injuries to bone, accessibility and technical ease of removal, one must be wary of too extensive surgery or attempts at extraction without sufficient exposure or adequate localization of bullets or bits of shrapnel. Deeply embedded in the tissues the foreign body, if it is not too large, will not prevent in many cases the healing of the wound provided there is adequate drainage. A patient treated in this manner will be saved the severe immediate trauma that removal would cause. It is also frequently true that the opportunity for a careful and gentle search in the tissues for the missile is not present at this time and severe damage to vital parts, nerves and blood vessels may result from the inability to identify anatomical parts because of distortion, lack of proper equipment or necessary haste.

A foreign body pressing on a major nerve or vessel demands early removal, the time of removal being determined by a careful study of the effect of this pressure. Prompt relief of symptoms is usually experienced when there is relief from the pressure.

Foreign bodies embedded in the skin should be removed as soon as the patient's condition permits.

Late Treatment—When a patient has had an embedded foreign body in the tissues for weeks or months the factors determining the form of treatment have changed from those present immediately after the wound was received. The process of healing has by this time surrounded the object with fibrous tissue and in many instances has completely encapsulated it. Those that have not been completely encapsulated are connected with the surface by sinus tracts that drain

either intermittently or continuously. Where there has been *injury to bone* an associated osteomyelitis is usually present and the drainage is more likely to be profuse. All cases having draining sinuses are suffering from chronic sepsis of various degrees of severity with a disturbance of nutrition as one of the results. Treatment in these cases is the treatment of osteomyelitis with the necessary addition of removal of the foreign body without which healing rarely occurs. As a preliminary to surgical therapy, however, as found by Lyons* the patient's deficient nutrition must be cared for which includes the administration of a high protein diet to correct the hypoproteinemia present. The use of penicillin immediately before surgery as well as postoperatively is indicated. It is best administered by intramuscular injection which may be combined advantageously with local application. Where the tract followed by the missile is long or passes in close proximity to important structures it is frequently better to incise through a clean field in removing it.

Consideration of the size of the missile, its location in relation to vital or important structures, the presence or absence of symptoms attributed or attributable to it, evidence of migration and the technical difficulty of extraction are all factors to be considered in determining the necessity for removal. The question of the size of a foreign body as an indication for removal depends in great part on its location and there is no generalization that is applicable to all cases which is also true in considering bodies that are located in vital or important anatomical structures as in these latter cases the hazard of removal may be great. Foreign bodies that are migrating through the tissues should be removed. This rarely happens and is confined to bodies that have sharp points, are slender and can be easily forced through tissues by movement of the tissues pressing on their bases.

Patients who have healed wounds may or may not have *symptoms* from the presence of a foreign body. Symptoms consist of local discomfort due to the presence of the missile surrounded by scar tissue producing a continuous irritation and to pressure on vessels or nerves which may be felt at points supplied by these structures. Disturbances of the vascular, motor, sensory or sympathetic nerve supply may be experienced. The important differential diagnosis to be made in the presence of definite evidence of an organic basis for these symptoms is to determine whether they are caused by the presence of the missile or are a result of the injury and scarring which has resulted from its passage through the tissues. If the symptoms are a result of the latter, removal alone will not give relief and may add to the disability suffered. Those patients who as a result of neurotic tendencies attribute to the presence of a foreign body pain and discomfort for which its presence does not account will gain nothing by its removal if

than very minor surgery is required and will be found later to complain of symptoms related to another anatomical part. Such cases should be treated by a psychiatrist.

The technical difficulty in extraction should receive major consideration always bearing in mind that very frequently the difficulties encountered are not apparent on physical or radiographic examination of the patient. As a result there is a tendency to underestimate the magnitude of the procedure and in rare instances when so deceived it is better to close the operative wound without removing the foreign body than to carry on a prolonged search with the consequent damage to the tissues.

CASE REPORTS

Case I.—The patient, a twenty-year-old Marine Corps private, sustained the right hip during the invasion of Bougainville. At the time of the injury the patient had transient paralysis and anesthesia of the leg which lasted for two



Fig. 520—X-rays of the pelvis and upper thigh revealed a large bullet lying beneath the symphysis pubis just lateral to and above the prostate gland.

hours. The next day when he awoke he found the leg cold and numb. As a measure of immobilization the patient had a plaster splint applied. He was returned to the hospital for further treatment. Physical examination on admission showed atrophy of the hamstring muscle and loss of the reflex of the leg sensory loss in the distribution of the posterior femoral cutaneous nerve and an ankle jerk in the affected side. X-rays of the pelvis and upper thigh (Fig. 520) revealed a large bullet lying below the symphysis pubis just lateral to and above the prostate gland. The next three days course had little effect on the patient's condition. The patient's wound was healed soon after the operation. In the aspect of the right buttock. At the present time the patient is not suffering from any symptoms that are a result of the present location of the bullet. X-ray and physical therapy have given marked improvement but it is as yet too early to know the degree of recovery possible under this treatment. The patient has however been treated very surgically. Exploration of the tract of the bullet is not at present indicated.

Comment—The above case is illustrative of excellent surgical judgment exercised in the early treatment and at present presents a therapeutic problem which can in no way be solved by removal of the missile. An early attempt at removal might well have ended fatally or in the absence of accurate localization have increased the damage done by the bullet. Either injury to the sciatic nerve or contusion of the nerve followed by the formation about it of a scar which is causing irritation is responsible for the present symptoms. Injury to the soft parts and the presence in them of scar tissue formed in healing have added also to the disability.

CASE II—A twenty-one year-old sailor sustained shrapnel wounds of the right thigh and jaw suffering a fracture of the latter six months before admission to a naval hospital. Both wounds had healed quickly and well though the shrapnel had not been removed from the thigh following the injury. His chief complaint on admission was a pain in the anterior surface of the right thigh and a sensation on standing of "his leg giving way." The pain was aggravated on lying down and became more severe in rainy weather causing him to walk at times with a decided limp. Physical examination revealed a healed scar the size of a twenty-five-cent piece on the medial side of the right midthigh. All motions of the leg and thigh were normal and there was no evidence of nerve or vascular damage. There was no muscular atrophy. X-ray examination showed a small metallic foreign body $\frac{1}{4}$ inch long medial to the femur and about inches below the lesser trochanter. There was no evidence of injury to the bone.

The thigh was explored and the wound closed without removal of the foreign body. Massive scarring was present and the further trauma necessary to reach the shrapnel did not seem advisable because of the small size of the foreign body and the inevitable further injury to the tissues which would have occurred had the operation been completed. The scarring found was not anticipated and at the time of operation seemed to overshadow the foreign body as a cause for the symptoms of which the patient complained.

Comment—This case illustrates again that the injury done the soft tissues rather than the foreign body may account for the symptoms of which the patient complains. It should also be noted that the wound had healed without a prolonged draining sinus or deep infection.

CASE III—A nineteen year-old seaman was admitted to the hospital following a bullet wound in the right chest sustained while overseas. The entrance wound 1 cm. in diameter was in the region of the fourth rib lateral to the nipple, and the wound of exit was near the inferior angle of the scapula in the region of the eighth rib posteriorly. There was a small chip fracture of the scapula. Excision of the wound and removal of bony fragments had been done following the patient's recovery from shock, shortly after being wounded. It had also been necessary to aspirate the chest repeatedly for a hydrothorax. The wounds healed and the patient recovered from the hydrothorax in a period of eight weeks.

On arrival at a naval hospital in the United States, it was discovered that there was a loud bruit over the area of the wound of exit. It was a continuous bruit with a systolic accentuation characteristic of an arteriovenous aneurysm and was of sufficient loudness to be easily heard with stethoscope and by the patient, for whom it constituted a serious annoyance. It was heard best

directly over the wound caused by the bullet's exit. There were no enlarged pulsating veins visible. After a thorough examination of the lung which consisted in addition to a physical examination of a bronchoscopic examination, a pneumogram and an arteriogram, no evidence of an aneurysm was found and a cooperative diagnosis was made of an arteriovenous aneurysm of the eighth intercostal artery and vein. There was no cardiovascular embarrassment present. This area was explored surgically but no evidence of an aneurysm was found. Considerable time was spent in the operation which included a resection of part of the eighth rib. It was felt that the patient had been subjected to as much trauma as was safe and the wound was closed.

After further study and after the operative wound had completely healed the patient was again operated upon the pleural cavity being opened for exploration.

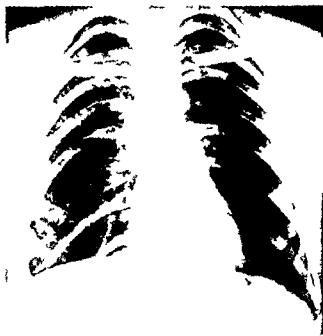


Fig 521—The foreign body that was responsible for the aneurysm is seen over the 10th rib posteriorly on the right side. This x-ray was made in the period between the first and second operations.

tion. Parietal and visceral pleura were found adherent but were separated without injury to the lung. A stethoscope was then applied to the lung. No breath could be heard, however, until the instrument was placed over the area of the eighth intercostal artery and vein at a point immediately below the wound. Exit. It was found that pressure over the artery stopped the bruit. The artery and vein were ligated proximal and distal to the bruit which then disappeared. A careful dissection was made of the artery and vein between the ligatures and the aneurysm was found. There was a slight dilatation of the vessels and nothing else was noted as the area where they communicated was injured in the dissection. Careful hemostasis was carried out and the chest wound closed. Coalescence was uneventful. Careful reexamination of the x-ray plates (Fig 521) after the second operation revealed the foreign body that had apparently been the cause of the aneurysm.

Comment—This case is of interest because of the unusual location of the aneurysm as well as illustrative of some of the problems found in dealing with war wounds. The bit of metal which was a part of a bullet appeared on the x ray to be a little larger than the head of a pin and was of little importance. The symptoms were due to a vascular injury caused by the passage of the missile into the posterior chest wall from which it did not emerge. It was unfortunate that a second operation was necessary but it seemed correct to explore the area of the wound of exit rather than an intercostal interspace below as the bruit was best heard in this area and the foreign body that was later assumed to be responsible appeared very small. No attempt was made to remove the foreign body. The justification for the surgery in this case is based largely on the relief obtained by the patient by removing a constant source of annoyance as the bruit was quite audible to him. While the condition became worse while the patient was being studied in that the bruit became louder it is questionable as to whether it would have ever produced cardiovascular embarrassment or other disabling symptoms.

CASE IV—The patient an eighteen year old seaman was admitted because of a gunshot wound of the right leg. The bullet had fragmented and at the time of the original injury two fragments were removed from the region of the knee. Because of an associated fracture of the upper third of the tibia the patient was in a cast for four months. He came under our care some months later complaining of pain in the right thigh leg and foot cramping of the muscles of the calf of the leg and aching pain throughout the entire thigh and leg during cold damp weather. Physical examination showed all joint and muscle action to be normal. There were healed scars lateral to the middle of the tibia the original entrance wound and below the knee where the previously mentioned foreign bodies had been removed. These scars were painful to pressure and deep pressure over the upper third of the leg caused pain. X ray examination in this area revealed a large metallic foreign body behind the tibia 8 cm from the knee joint. There was considerable deformity of the bone at the site of the foreign body indicating an old comminuted fracture with considerable excess callus formation. Because of the size of the metallic fragment and the continued pain and incapacity the foreign body was removed. The operation was extremely difficult and long as the fragment was embedded in dense scar tissue and callus. The patient's postoperative course was uneventful but he continues to have the aching of the thigh and leg and pain over the tibia.

Comment—This case is presented to emphasize again that removal of a foreign body may not only be difficult but may not materially improve the patient's signs and symptoms. It is difficult to determine how much of his trouble is due to actual injury and no doubt his pain will improve with time but we feel that we have probably accomplished little by removal. He is easily influenced by suggestion and we have probably given him added cause for associating the injury with many signs and symptoms which have no organic basis. It is however true that the removal of the foreign body gave him mental relief.

CASE V—The patient a twenty-year-old seaman was admitted to the hospital complaining of chest pain which followed a chest wound received in action in the Mediterranean theater of operations. The wound was inflicted by a machine gun bullet from a strafing airplane. The bullet penetrated the posterior chest wall traversed the right lung and lodged just beneath the sternum to the right of the midline near the aortic arch as shown by x-ray (Fig 52). The original wound had healed and the patient was transferred to the continental United States because of pain on coughing or deep breathing soreness in the chest and position of the bullet near vital structures. When lying quietly in bed resting little discomfort was felt while exercise made all his symptoms worse.

The bullet was removed by making an incision between the first and second ribs on the right side where it lay near pleural near the center of the manubrium.



Fig 5—The bullet penetrated the posterior chest wall traversed the right lung and lodged just beneath the sternum to the right of the midline near the aortic arch as shown by x-ray.

and just above the aortic arch. His postoperative convalescence was normal and he was discharged to full duty. Some very small metallic fragments which lay about the bullet were not removed. At the time of his return to duty he still complained of pain and oneness in the chest. There was considerable pleural reaction about the bullet which may account for the persistent coughing and deep breathing. It is of interest that as in many wounded the soldier hardly realized he was injured at the time he was hit despite the engulging pain and discomfort.

Comment—This case is presented because the missile a machine gun bullet lay near vital vascular structure which we felt was one justification for removal. With the removal of the bullet there is

reason to feel hopeful that all signs and symptoms will disappear as we feel that the pleural reaction will now subside

SUMMARY

We have tried to present a few of the problems found in dealing with foreign bodies. The subject is very large and enters all fields of surgery yet there are definite principles which apply to the handling of all cases. We have presented five cases showing foreign bodies in the lung, pelvis and lower extremities in all of which the wounds had healed without prolonged drainage and the foreign bodies had become well encapsulated.

These cases constitute a challenge to careful study of each individual case. Roentgenographic evidence of a foreign body should be looked upon as an aid in its removal and not necessarily a reason for removing it. It should also always be remembered that x rays give the foreign body the appearance of being easily removed while in fact its removal may be a major procedure.

CURRENT PRACTICE IN TREATMENT OF THORACIC EMPYEMA*

LT COMMANDER EDWARD M. KENT AND COMMANDER
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THE treatment of thoracic empyema was brought nearer to standard *ized surgical procedure* by the work of the Empyema Commission headed by L. A. Graham in World War I the results of whose investigations clarified the principles upon which successful surgical treatment rests. The three principles of treatment established by that commission are: avoid open pneumothorax in the early stages of empyema; give careful attention to the nutrition of the patient; and prevent chronic empyema by prompt sterilization and obliteration of the involved pleural cavity.

CHOICE BETWEEN CLOSED AND OPEN DRAINAGE

Much has been said and written in recent years about the two types of surgical drainage employed and there has been some controversy concerning the merits of *closed drainage* as opposed to *open drainage*. By open drainage is meant the resection of a portion of a rib 2 to 2½ inches in an adult and the insertion of a rubber tube drain which we believe should have a diameter of 1 inch. Closed drainage implies the intercostal insertion of a smaller rubber tube or catheter the distal end of which is placed in a vessel containing water in a sufficient amount to keep it well below water level during the inspiratory phase of the respiratory cycle to which may be added apparatus for the creation of negative pressure or the carrying out of tidal irrigation.

Open drainage is to be avoided in cases in which localization has not taken place and is preferable in those cases in which this has occurred such as empyemas caused by the pneumococcus which are usually well localized contain thick pus and considerable fibrin. Adequate drainage is provided in this manner if the drain is placed in the empyema cavity at its most dependent point.

Organisms other than the pneumococcus notably the streptococcus and staphylococcus yield thinner pus produce a greater toxicity in

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The opinions or assertions contained herein are the private ones of the writer and are not to be construed as official or as reflecting the views of the Navy Department or the naval service at large.

The medical management of the cases described is carried out by Commander A. W. Hilly (MC) U.S.N.R.

the patient, create larger empyema spaces and are accompanied by a comparatively nonadherent lung. These conditions frequently exist in children with thoracic empyema regardless of the infecting organism. We believe that under such circumstances closed drainage is the method of choice. It is frequently found that cases treated by closed drainage will later require or do better with open drainage by rib resection.

The decision as to the use of *tidal irrigation* is dependent on the clinical findings of the individual case. It can be applied to either open or closed drainage but in our experience is rarely needed in the former. Its chief use we feel lies in the treatment of those cases in which the pus becomes too thick to drain through the intercostal catheter and in those cases in which fibrin clots and fragments occlude the drain thereby preventing adequate drainage. The irrigating solution may be sterile normal saline solution, Dakin's solution or 1:3,000 aqueous azo-chloramid solution, the latter being available with or without a wetting agent incorporated into the formula.

It has been estimated that 80 per cent of cases of empyema are caused by pneumonia and since pneumonia may be caused by many different bacteria so may the complicating empyema.¹ While one or another of the pneumococci is the chief cause of pneumonia and hence of empyema, there is some variation of the ratio of occurrence from year to year, epidemic to epidemic and place to place. While it has been difficult to arrive at an accurate estimate of the incidence of empyema complicating pneumonia, the general over all figure has been placed at 5 to 6 per cent before the use of sulfonamide therapy and from 1 to 2 per cent since sulfa drugs have been so widely used. The decrease in the occurrence of empyema resulting from the use of the sulfa drugs appears now to have been affected chiefly among the pneumococcal infections.

Thoracic empyemas occurring as a result of war injuries are treated on the same basic principles as any infection of the pleural space. These cases however often require special consideration because of chest wall or lung injury, hemothorax and injuries of other parts. While such cases are occasionally encountered in civilian practice they are rare and constitute a field which will not be discussed in this presentation.

Fundamental Principles of Drainage—Whether open or closed drainage is chosen, there are certain fundamental principles which must be emphasized. Drainage must be adequate and this implies that it shall be properly located in a dependent position according to the position of the pleural abscess and once established such drainage must be maintained by close personal management. Care must be taken to prevent obstruction of the drainage tubes by fibrin granulation tissue and kinking. Adequate drainage may be lost by adopting

a routine policy of shortening the tube a certain amount each day rather than shortening it as healing and obliteration of the cavity justify. Should the drainage tube slip out it should be replaced by one familiar with the case. The drainage tract will become appreciably narrowed if the tube is out of place for even a few hours and it is sometimes difficult to replace the tube the full and necessary depth. At times a tube may be too long and if no lateral fenestrations have been cut into its wall pus may collect about the tube until it reaches the end of the tube. The size of the empyema cavity should be determined by filling it with sterile saline solution periodically and a record should be made of the result so that the progress of the oblitative process can be followed. When the volume is reduced to 15 to 20 cc the remaining space is usually that within the lumen of the tube and a smaller drain can be inserted. It is our practice to have a tube in place until the cavity measures less than 10 cc with the tube out of the drainage tract. Roentgenographic studies are valuable during the course of the healing process.

EFFECTS OF SULFONAMIDE THERAPY FOR THE PRIMARY INFECTION ON THORACIC EMPYEMAS

The effects of sulfonamide therapy upon thoracic empyemas are deserving of consideration. Buford and Blades have called attention to the increased occurrence of atypical empyema pockets which are seen in cases in which the complication arises during sulfonamide therapy for the primary infection. They point out that the pockets are often multiple, nondependent in location, interlobar and the like. In their experience secondary operations are more often required to provide continued adequate drainage. Re-expansion of the lung and obliteration of the cavity were delayed.

Our own experience has led us to feel that sulfonamide drug therapy reduces the incidence of empyema complicating pneumonias and occasionally sterilizes the pleural effusion if employed in adequate dosage before the fluid becomes frankly purulent. The local use of sulfonamide drugs within the pleural cavity is of questionable value. Empyemas occurring while the pneumonitis is under active sulfonamide therapy usually progress to frank suppuration and often assume bizarre types. Empyemas which arise under such circumstances may offer unusual diagnostic and therapeutic problems. There may be pockets of frank pus with positive bacteriologic studies yet the cases may show minimal or no clinical evidence of infection. Multiple limited pockets of suppuration occur more commonly than heretofore observed. It is not uncommon to encounter empyema pockets in non-dependent areas even apical in distribution.

An interesting case of thoracic empyema treated by the sulfonamide drugs alone might be described to advantage at this point.

CASE I—A nineteen year-old pharmacist, during convalescence from scarlet fever developed an acute respiratory complication that was diagnosed as a left lobar pneumonia. Upon admission six days after onset of respiratory symptoms there was a left pleural effusion. The patient had received intensive sulfadiazine therapy prior to transfer to this hospital and the use of the drug was continued. The chest x ray upon admission revealed a pleural effusion and the

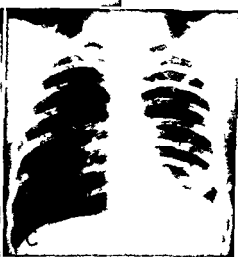


Fig 523—A Chest film taken on day of admission reveals the apical empyema pocket. This is an example of the atypical empyemas seen in patients treated with sulfa drugs B Continued extension of empyema in spite of aspiration and use of sulfa drugs C Appearance of chest x ray upon discharge from hospital

significant observation in this case is the apical concentration of the effusion (Fig 523 A). This is the type of atypical empyema which is seen in patients undergoing treatment with sulfa drugs.

Thin pus aspirated from the left pleural space on the day of admission revealed hemolytic streptococci when cultured. In spite of the continuation of sulfadiazine therapy and repeated aspiration, the pleural effusion continued to

form at an increasingly rapid rate and the empyema became more tense (Fig 523 B). The apical pockets persisted and an extensive pleural infection followed the pus becoming thick within six days after admission. Aspiration and continued sulfadiazine therapy proved useless and closed drainage was instituted fifteen days after admission.

An adequate trial of sulfadiazine in this case failed to halt or retard empyema formation nor was it possible to avoid surgical drainage. Postoperative convalescence was uneventful and the patient was discharged to duty two months later with a minimum of residual pleural thickening (Fig 523 C). The apical empyema pocket drained adequately into the generalized pleural abscess and separate drainage of it was not required.

PLEURAL EFFUSION SECONDARY TO ABDOMINAL INFECTION

As previously stated pneumonia is the most common cause of empyema. Barring traumatic chest injuries in time of war it is probable that the second most common source of pleural infection is associated with a primary suppuration some place in the abdomen with subdiaphragmatic extension and later supradiaphragmatic infection. The multiplicity of lesions and the gravity of the complications make for higher mortality and greater morbidity for the cases that fall into this group. The intra-abdominal lesion or lesions require treatment based on the necessities of the individual situation and such treatment usually has been instituted before the pleural complication has to be met. Two examples of such a case follow.

CASE II—A thirty-four-year-old private first class was admitted to the hospital on April 1, 1944, with acute appendicitis of about twelve days duration. He was exceedingly ill with generalized peritonitis and a chest film on the first day revealed elevation of the right diaphragm (Fig 524 A). Two days of preparation were resorted to before laparotomy and when the abdomen was opened the appendix was removed, the appendiceal abscess drained and the subphatic space and flank or gutter were also drained. A culture of the peritoneal pus at this time revealed a mixed infection.

The postoperative course was stormy. Purpura, generalized edema, dyspnea, disorientation and delirium were all present. Pleural effusion was demonstrable clinically on April 4 and by x-ray on April 7, 1944. Sulfadiazine therapy had been instituted upon admission and was continued. Aspiration of the pleural fluid revealed thin pus from which the colon bacillus was grown in pure culture. The organism was demonstrated in the pleural fluid repeatedly and it was shown not to be susceptible to penicillin. Repeated daily aspiration as employed for nine days the foul-smelling pus continually reforming and becoming constantly thicker. Closed drainage was established April 14 (Fig 524 C) with prompt improvement. This was followed by rib resection on April 27 to improve drainage. Subsequent obliteration of the large anterior empyema pocket was achieved rapidly.

Healing was complete by the end of six weeks and the abdominal situation cleared without further intervention. The elevated diaphragm shown in Figure 524 A, the clinical history and the finding of the

colon bacillus in the pleural effusion all tend to indicate that the pleural suppuration was tertiary to acute appendicitis with peritonitis and secondary to a resulting subdiaphragmatic abscess. Transdiaphragmatic drainage of the latter collection was not required suggesting that it

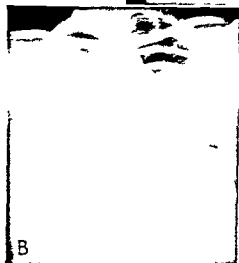
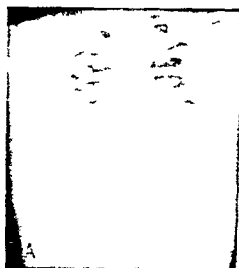


FIG. 5 + (CASE II) — A Chest film reveal no elevation of right diaphragm upon admission to hospital with generalized peritonitis. B Demonstration of pleural effusion six days after admission. Pure culture of *Escherichia coli* was grown repeatedly from the pus aspirated in this case. Aspiration and drainage was necessary anterior to the midaxillary line and, on thoracoscopy, anterior location of empyema was confirmed. C Chest film after drainage (closed) had been established.

may have drained spontaneously into the pleural cavity thereby giving rise to the pleural infection.

CASE III — A nineteen year-old seaman first class was admitted to the hospital on December 4 1944 with acute appendicitis, the appendix having perforated

a generalized peritonitis was present. Immediate operation was performed. Subdiaphragmatic abscess formation was demonstrated three days later and right pleural effusion was present on January 1, 1944. Aspiration of the pleural fluid as done and a thin slightly cloudy pus was obtained from which gram positive rod shaped bacilli were cultured. Sulfadiazine therapy was employed from the time of the operation. A subdiaphragmatic abscess was drained surgically on January 4, 1944 and although the pleural effusion continued to form rapidly (Fig. 55) it soon became negative to culture and never became purulent. Drainage was not employed and the effusion subsided on aspiration therapy. Sulfadiazine was employed maintaining a blood level ranging between 7 and 11 mg per 100 cc. Culture of the abdominal pus at laparotomy had revealed a pure culture of coliform bacillus which was not susceptible to penicillin.



Fig. 55 (CASE III) — Massive right pleural effusion demonstrated in case of right subdiaphragmatic abscess. Although initial aspirations yielded positive cultures the fluid soon became negative, never turned purulent and cleared completely without drainage.

This case represents one which responded to nonoperative therapy of pleural effusion and a stage at which surgery was considered was not reached. The effusion was extensive and at first gave positive cultures of an unidentified organism but soon became sterile. Of course drainage of the subdiaphragmatic collection may well have played the major role.

PENICILLIN THERAPY

Of great interest at this time is the effect of penicillin on any and all types of infection and the quest for this knowledge as to thoracic empyema is no exception. Experience is now too meager to provide the full answers to the many questions which come up but progress is being made and initial findings have suggested provisional conclusions that as this is written but w

subject to amplification and revision with increasing experience. Some projected changes in therapeutic technic have already been formulated for trial as result of the limited experience we have had. Another important factor is the increasing availability of the drug which will allow more general use in the treatment of pneumonia and will demonstrate the degree of efficiency it possesses in reducing the occurrence of complications such as empyema.

The greatest effect of penicillin is upon the gram positive cocci. Among gram negative cocci which are susceptible however are found such important organisms as the gonococcus meningococcus and Micrococcus catarrhalis but these are of no importance in the empyema problem. Bacilli are less vulnerable especially *Escherichia coli* and it is useful to apply sensitivity tests to organisms which have questionable qualities of vulnerability to penicillin. It now seems certain that penicillin is far more potent on vulnerable organisms than the sulfa drugs. There are however certain organisms which are more vulnerable to sulfa drugs than to penicillin in its present stage of development.

In the treatment of empyema the optimum period for its use is early in the disease as soon as the diagnosis is made. The chances of success are greatly reduced after the effusion has become purulent. Local use of the drug within the pleural cavity is probably essential and is combined with intramuscular or intravenous use although it may eventually be shown that local use alone will be the procedure of choice. Parenteral application alone has been disappointing and present information suggests that penicillin does not reach the pleural space in effective concentrations once definite infection has taken place. When replacing aspirated pleural fluid by penicillin we have currently chosen to introduce the drug in a quantity of normal saline equal to half the volume of fluid removed. A standard concentration of at least 250 units per cubic centimeter preferably 500 units is employed. Daily injections are necessary to maintain a bacteriostatic level in the pleural space. The reason for employing this technic is to provide sufficient vehicle for the drug to come in contact with the whole interior of the empyema cavity. Projected changes in this phase of the technic include an increase in the dose per injection and more frequent aspiration injection treatments. The volume of the pleural abscess and the rapidity of the effusion will vary and the application of the technic will be modified by these factors in each case. Once frank pus is present our experience to date indicates that penicillin therapy accomplishes little good. Two examples can be shown at this point.

CASE IV—A nineteen year-old fire control man third class as admitted to this hospital on December 1, 1943, with a history of acute respiratory infection antedating hospitalization by a few days. When first seen the clinical signs of a right empyema were present. X-ray confirmation was made and an

extensive effusion was further produced by aspiration of a large quantity of frank pus. Cultures of this material yielded growths of *Staphylococcus aureus* repeatedly and the organisms were remarkably susceptible to penicillin. Therapy was carried out for fifteen days with a total intramuscular dosage of 565,000 Oxford units and 580,000 additional units were instilled within the pleural cavity (Fig. 526 A and B). Although 1,500 penicillin concentrations ranged between 0.04 and 0.16 florey units the pleural pus consistently failed to show enough penicillin to inhibit growth of colonies present on test media. The effusion became even more purulent and continued to form in large amounts. Thoracotomy was established by rib resection and open drainage on December 9 and followed by a prompt and uncomplicated recovery. This man returned to full duty in March 8, 1944.



Fig. 526 (CASE IV) —A and B. Anterior posterior and lateral views of chest showing the extent of the empyema cavity. Full results present the result of ingress of air during aspiration instillation treatment and show a measure of the extent of the cavity.

CASE V —A fifty-eight year old patient was admitted to the hospital on December 15 with bilateral pneumonia. A definite cardiac friction rub with heart in auricular fibrillation were also noted. The sputum and the blood culture yielded pneumococcus Type VII on culture. Sulfadiazine therapy was instituted at once 37 g. being administered in even lots and the blood level of the drug ranged between 9 and 14 mg. per 100 cc. Although this patient was very ill when first seen progress was favorable the pneumonia cleared blood culture became negative, pericardial effusion failed to develop and heart in feeble regular rhythm. A left thoracic empyema developed rapidly during this period and the pneumonia, Type VII, cultured therefrom. The effusion became frankly purulent and sulfadiazine therapy was replaced by penicillin. Total dosage was 100,000 Oxford unit intramuscularly and 200,000 units intrapleurally with resulting blood levels ranging from 0.1 to 0.16 florey units. Nevertheless the pleural effusion remained highly positive on

culture and thick pus continued to form rapidly. Thoracostomy by rib resection and open drainage was performed on January 14 1944 with prompt recovery. This patient was discharged well on April 14 1944.

These two patients represent typical experience with the use of penicillin once the empyema fluid has become frank pus. Ordinarily the organisms encountered in these two cases are considered to be susceptible to the drug yet surgical drainage was required. This has proved true with the sulfa drugs and it undoubtedly will be the same with penicillin. It is rare that such a pus pocket can be sterilized and even when it is it must be evacuated since experience has demonstrated that absorption is not to be anticipated.

When treatment is begun sufficiently early it has proved to be perfectly possible to sterilize pleural effusion by the use of penicillin provided the causative organism is vulnerable to the drug. In spite of these bacteriologic successes however the therapeutic effects have left much to be desired. Experience thus far has been that some form of drainage of the pleural cavity often becomes necessary since the effusion persists continues to form or cannot be aspirated adequately due to fibrin clots within the cavity. Greater emphasis upon intra-pleural instillation of the drug increased dosage earlier treatment and more meticulous attention to the aspiration technique early in the stage of effusion may obviate some of the difficulties encountered to date.

The occurrence of *fibrin clots* in pleural effusion which has been sterilized by penicillin therapy has actually presented a major barrier to successful nonoperative treatment. These fibrin bodies vary in size from flecks to large masses and they thwart efforts to aspirate the fluid. They render catheter drainage unsatisfactory by repeatedly blocking the lumen. Even open drainage with a large tube requires unusually careful attention on this account.

Blades³ has met this problem to his satisfaction by opening into such empyema pockets through a small intercostal incision evacuating the contents completely and closing the wound after catheter drainage has been established either through one angle of the thoracotomy incision or by means of separate dependent trocar and cannula opening. Suction is applied to this catheter drain to hasten obliteration of the pleural space. Three cases of penicillin treated empyema are demonstrated below.

CASE VI—A twenty year old sailor was admitted to the hospital on February 16 1944 with pneumonia left lower lobe. Sputum revealed pneumococcus Type V. Within forty eight hours a left pleural effusion became established (Fig 577 A) and pneumococcus Type V was cultured from the chest fluid. Sulfadiazine had been administered until the pleural effusion occurred when a change to penicillin was made. A dosage of 300 0 Oxford units intramuscularly was employed until a total of 2 160 000 units had been given. In this case none of the drug was instilled into the pleura when thoracentesis was performed. The pleural

effusion never became purulent and the cultures became negative within six days. Despite aspiration the pleural space refilled with fluid and on March 20, 1944, closed drainage was established and negative pressure applied. The large empyema space was obliterated and the man was ready for duty in six weeks (Fig. 527, C).

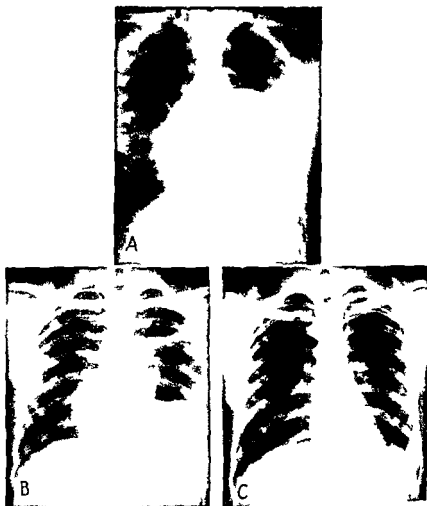


Fig. 527 (Case VI).—A Chest film revealing left empyema. Culture of fluid yielded pneumococcus Type V. B Appearance of chest film during aspiration on penicillin therapy. Effusion sterile at this time. C Appearance of chest at time of return to active duty.

This case represents an exception to a provisional rule which we feel to be sound in the light of our experience to date, namely that *intrapleural* use of penicillin is required to obtain optimum results. None was so used on this man yet the pleural effusion was made sterile to culture. It was necessary to drain the effusion in spite of the change.

CASE VII—A twenty-one year-old sailor was admitted to the hospital on December 17 1943 suffering from a pneumonia on the left side. He was extremely ill and sulfadiazine therapy was begun at once maintaining a blood level ranging between 6 and 14 mg per 100 cc. The clinical response was gratifying nevertheless a left pleural effusion developed on the sixth hospital day. The chest fluid grew hemolytic streptococci when cultured and penicillin was substituted for sulfadiazine. The pleural effusion became negative to culture on December 30 1943 and the fluid never became pus. A total dosage of 1 920 000 Oxford units of penicillin was given intramuscularly and 600 000 units were instilled into the pleural space at the times of aspiration. The pleural effusion continued to form rapidly and was of a thin semipurulent character though negative to culture and smear. Thoracostomy with closed drainage was performed on January 11 1944. Postoperative convalescence was somewhat prolonged two and a half months being required to achieve complete healing after drainage.

CASE VIII—A twenty five year old sailor was admitted to the hospital on December 20 1943 with a pneumonia of the left lung. Sulfadiazine therapy was instituted and a blood level varying from 7 to 14 mg per 100 cc was maintained. Clinical response to therapy was very satisfactory but a delayed left pleural effusion was present on the fourteenth hospital day. It soon became a massive effusion (Fig 5 8 A) and culture of this fluid made on the day the effusion was detected yielded hemolytic streptococci. Penicillin therapy was instituted at once a total dosage of 3 680 000 Oxford units being given intramuscularly and 500 000 units instilled into the pleural space upon aspiration. Thoracentesis was attempted daily for twenty two consecutive days but clots of fibrin rendered it impossible to remove satisfactory amounts. The fluid never became thick pus and was rendered sterile to culture and negative upon study of smears on January 8 1944 five days after institution of penicillin treatment. The pleural cavity remained extensive and effusion continued to form. Difficulties of aspiration caused by the fibrin clots contributed a great deal to the necessity of surgical drainage which was done by the closed method on January 25 1944. The films taken after drainage revealed an extensive intrapleural cavity and a markedly thickened parietal pleura (Fig 5 28 B). Closed drainage was maintained by water seal and three months passed before healing took place (Fig 5 8 C). Residual thickening of the pleura was still present when this man was returned to duty.

This case affords an example of those individuals who produce quantities of fibrin clots and flecks on a pleural effusion. Even though penicillin therapy achieved sterilization of the effusion a very large empyema cavity was created which possessed a wall of thickened pleura thus creating favorable conditions for chronicity. In retrospect it might have shortened the morbidity had suction been applied in an effort to accelerate the rate of obliteration of the cavity.

It is important to appreciate that these cases of empyema which were treated with penicillin did not have that drug until the pleural effusion had become established. All were given sulfadiazine during the pneumonitis. Our experience with penicillin in pneumonia is limited. We feel that a further reduction in the incidence of empyema may be anticipated.

effusion never became purulent and the cultures became negative within six days. Despite aspiration the pleural space refilled with fluid and on March 20, 1944, closed drainage was established and negative pressure applied. The large empyema space was obliterated and the man was ready for duty in six weeks (Fig. 527, C).



Fig. 527 (Case VI)—A Chest film revealing left empyema. Culture of fluid yielded pneumococcus Type V. B Appearance of chest film during a pirated penicillin therapy. Effusion sterile at this time. C Appearance of chest at time of return to active duty.

This case represents an exception to a provisional rule which we feel to be sound in the light of our experience to date, namely that *intrapleural* use of penicillin is required to obtain optimum results. None was so used on this man yet the pleural effusion was made sterile to culture. It was necessary to drain the effusion in spite of the bacteriologic change.

close, the majority will be followed by chronic empyema. This is due to the loss of normal intrapleural pneumodynamics brought about by the fistula and the resulting retardation of expansion of the lung. An example may be offered which demonstrates these factors.

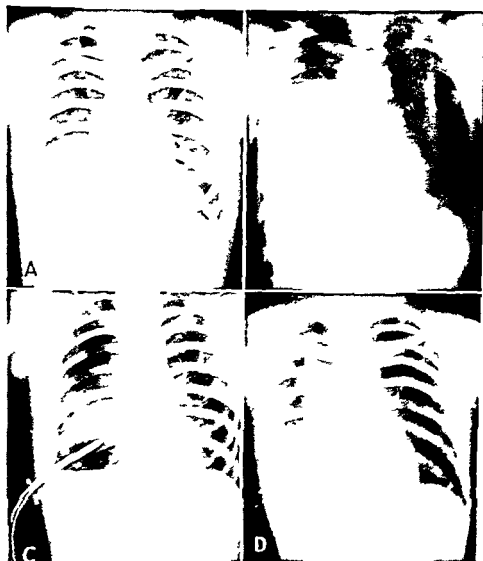


FIG. 9 (Case IV).—A. Chest film reveals pneumonia in right lower lobe. Right empyema with fluid level. This film was taken before aspiration was attempted and indicates presence of bronchopleural fistula. B. Chest film after closed drainage had been established. The extensive empyema space is clearly visible. Fortunately, some lung surface has remained adherent to chest wall. C. Film revealing gradual re-expansion of lung. Fistula still open at this stage.

the pleural fluid yielded cultures of hemolytic streptococcus and Staphylococcus albus these organisms being constantly present in subsequent cultures. This man had been treated by sulfiazine from the day of admission and that drug was used throughout. Repeated aspiration of the pleural space as done as a therapeutic measure but also as a prophylactic measure to reduce the spill of infected fluid through the fistula into the respiratory tract. Because of the presence of the fistula no local therapy was employed with in the pleura. The effusion remained positive to culture and became frankly purulent.

Closed thoracotomy was performed on February 2, 1944. The degree of pulmonary collapse which had taken place by that time is clearly shown in Figure 529 C. Fortunately the lung was partially adherent to the chest wall. If it had not been a complete collapse of the entire lung would have taken place. Chronic empyema became established and re-expansion of the lung was greatly retarded as can be seen in Figure 529 D. This film was taken on May 10, 1944 and the lung had not yet re-expanded completely nor had the fistula closed. Altogether seven and a half months passed before the fistula had healed and the empyema cavity had become obliterated. No surgical intervention was employed because this man remained in poor physical condition throughout the duration of the chronic empyema.

Blades has recently employed a modified decortication operation coupled with simultaneous closure of the fistula. This is done through an intercostal approach which is closed tightly at the conclusion of the operation. Closed catheter drainage is established to which suction is applied and maintained. The released lung may thereby be inflated sufficiently to reach the chest wall and if this can be accomplished rapidly enough it will adhere thereto. Should the closed fistula reopen it is relatively unimportant if the lung has been drawn into contact with the thoracic cage and remains adherent to it. Certainly such a technique offers great advantages over allowing chronicity to persist and finally applying extensive plastic surgery to the chest wall.

SUMMARY AND CONCLUSIONS

An attempt has been made to show examples of typical problems which are encountered in the treatment of acute thoracic empyema. It is our belief that the fundamental principles have not been altered by chemotherapeutic measures and that delay in surgical intervention cannot be justified on the basis of results seen to date with either the sulfonamides or penicillin. There has been an appreciable reduction in the incidence of empyema as a result of sulfa therapy and it is fair to assume that a further reduction will result from the treatment of pneumonias with penicillin.

In some respects empyemas which occur during sulfa therapy offer more problems than heretofore have been seen. Observations will soon reveal whether penicillin treated pneumonia will have the same tendencies. In our opinion further work and improved techniques improve the results in treatment of empyema with penicillin but doubt that a substitute for drainage can be found in any case which demonstrates frank suppuration.

It is readily admitted that penicillin can be shown to sterilize a certain number of empyemas which are due to vulnerable organisms. Nevertheless we feel that at this time emphasis should be placed upon the fact that a negative culture and great clinical improvement may be so impressive that delay in establishing drainage may seem justified while in fact such delay has not proved to be harmless nor has it been shown to be of great therapeutic value when frank pus is present. Finally the value of penicillin in reducing toxicity of the empyema patient is rather striking and one must not underestimate the threat of pleural suppuration on this account.

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